Indian and Northern Affairs Canada
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GEOLOGY OF CARCROSS (105D/2) and part of ROBINSON (105D/7) MAP AREAS

by

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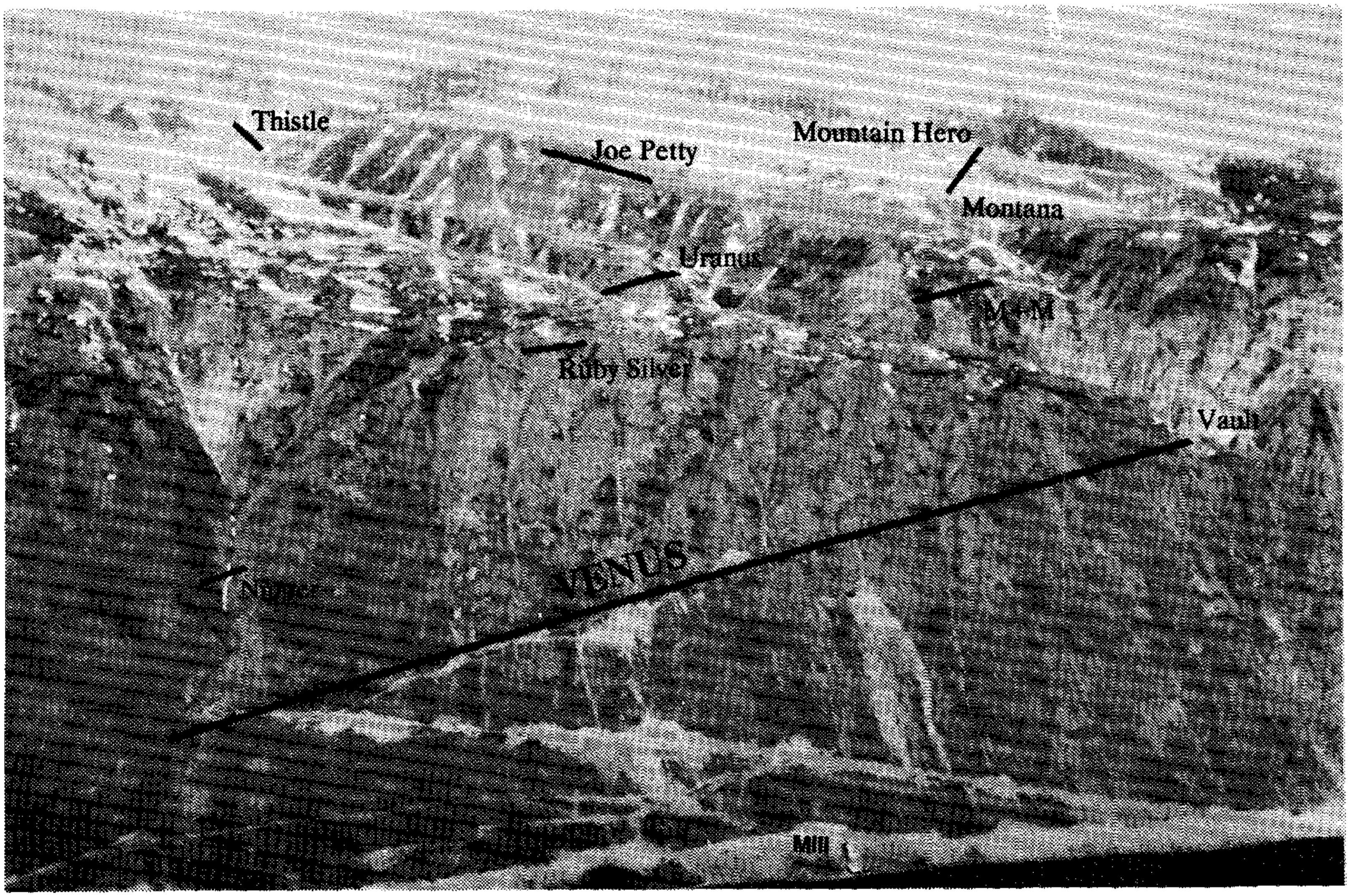

Frontispiece: Looking west across Windy Arm at the VENUS deposit and other mineral occurrences of the Montana Mountain massif. Approximately 150 000 tonnes of ore have been produced from this district, current reserves are slightly greater than 200 000 tonnes.

PREFACE

Prospecting first took place in the Carcross area in 1893 when miners travelled inland from the Pacific coast. Further exploration was stimulated by the Klondike gold rush in 1895 and by the completion of the White Pass and Yukon Railway in 1903. Gold-bearing quartz veins have been mined intermittently since that time and interest in them increased in the late 1970's with the rising price of gold.

This report describes the geology and mineralization of the Carcross and southwestern Robinson map areas.

This work was funded under the Mineral Sub-Agreement of the Canada-Yukon Economic Development Agreement, Contract YEDA 01/87.

This report accompanies the Geological Map of Carcross (105D/2) and Part of the Robinson (105D/7) Map Areas by C.J.R. Hart, K.S. Pelletier, J. Hunt and M. Fingland.

ABSTRACT

Geology of the Carcross (105D/2) and part of the Robinson (105D/7) map areas, south of Whitehorse, Yukon, were mapped at 1:50 000 scale during the 1988 field season. The map areas are within the Teslin Plateau and Boundary Ranges physiographic regions.

Rocks of the Atlin (Cache Creek) Terrane, Whitehorse Trough and Coast Plutonic Complex are each represented in the study area. The Atlin Terrane is bounded by the Nahlin thrust fault and the Crag Lake tear fault. The Nahlin Fault is westerly verging and was active during Late Cretaceous time.

The westernmost exposures of Whitehorse Trough strata are those of the structurally complex Tally Ho Shear Zone, the northern extension of the Llewellyn Fault. This structure involves rocks as young as Cretaceous.

Two ages of Cretaceous volcanic activity are represented by the Carmacks and Mount Nansen Groups. Rocks of the Montana Mountain volcanic complex are early Late Cretaceous in age (88-99 Ma).

Mineral occurrences of the Montana Mountain area are at least as young as Paleocene and are related to the Nahlin Fault. Other mineral occurrences in the area are spatially related to the Tally Ho Shear Zone.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Purpose and Scope of Study

Geological mapping of the Carcross (105D/2), and part of Robinson (105D/7) map areas, represents the second of a two year mapping program in the central part of the Whitehorse map sheet (105D). The Whitehorse Geological Mapping Project was undertaken by Aurum Geological Consultants, Inc. through a contract fiananced by the Canada-Yukon Economic Developement Agreement (Contract YEDA 01/87).

The project area (Figure 1) includes four 1:50 000 scale map sheets including Fenwick Creek (105D/2) and Alligator Lake (105D/6) map areas (Doherty and Hart 1988), the Whitehorse map area (Hart and Pelletier 1989) and the Carcross and Robinson map areas which were mapped concurrently during the summer of 1988.

The Carcross map area includes historic and currently explored precious metal vein occurrences. The project was initiated to provide detailed geological maps, documentation and correlation of map units, structural analysis, and geological controls and genetic models for mineralization.

Radiometric age dating of volcanic and intrusive rock units collected from within the project area is currently being undertaken by Dr. R. L. Armstrong at the University of British Columbia. A few preliminary age dates are cited in this report but supporting data was unavailable at this time. These and other age dates are scheduled to be released in the summer of 1989.

Location and Access

Carcross (105D/2) and Robinson (105D/7) map areas share a common boundary approximately 65 km south of Whitehorse (Figure 1). The southern boundary of the map area is the Yukon/British Columbia border. The village of Carcross (pop. 330), near the centre of the map area, is approximately 40 minutes by vehicle from Whitehorse.

Access is provided by the South Klondike Highway which traverses the map areas from north to south. The Tagish Road permits easy access to the mountains adjacent to it. The Montana Mountain road provides access to most mineral occurrences on the Montana Mountain massif. Mount Stevens in the extreme northwest portion of the map area is accessible by a secondary 4x4 road which joins the Annie Lake road.

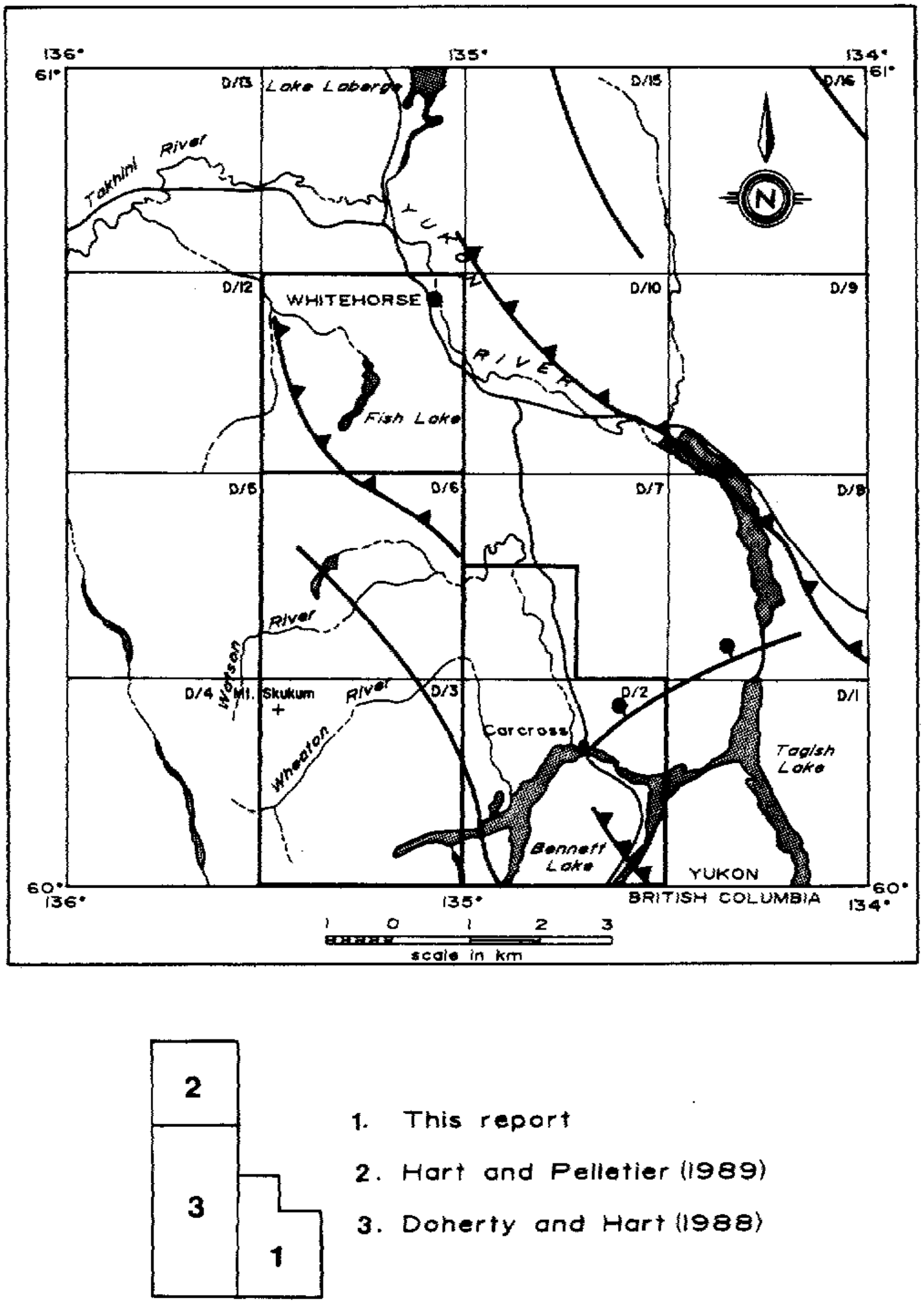

Figure 1. Whitehorse map sheet (105 D) divided into sixteen 1:50 000 map areas. Bordered area defines project area of the Whitehorse Geological Mapping Project. Dark lines represent major faults: thrust faults have teeth on upper plate; normal faults have dot on downthrown side; other faults, displacement is uncertain.

The White Pass and Yukon railway also traverse both map sheets and allows easy foot travel along its route. Exposures adjacent to Bennett, Nares and Tagish Lakes, and Windy and West Arms are accessible by boat. Helicopter access is required for regions south and west of Mount Matheson and the mountains above both sides of the lower Wheaton valley.

Glaciation and Glacial Deposits

Several glacial advances have covered the Whitehorse area during the Pleistocene. The most recent or McConnell advance took place approximately 30,000 years ago and advanced from the south and east. Glaciers carved out fiord-like depressions now filled by the waters of Bennett and Tagish Lakes. Wide U-shaped valleys were created by glacial movements north along the Wheaton and Watson River Valleys.

During deglaciation, glacial Lake Carcross (Wheeler 1961) formed and covered all parts of the map area below 975 m as indicated by wave cut terraces above Nares Lake. The lake may have formed as a result of damming by stagnant ice masses near Lewes and Annie Lakes. Pitted and hummocky, gravelly terrane with numerous pot-hole lakes are common at both localities. Water level dropped dramatically to approximately 825 m, probably in response to dam failure and lowered gradually to its present level. Raised beaches are well developed between 730 m and 825 m. Lake Carcross drained to the north through rivers in the Watson and Wheaton-Corwin-Annie Lake valleys. Once Lake Carcross had drained, accumulated deltaic sediment altered the coarse of the Wheaton River causing it to flow south (Wheeler 1961).

Exposure of beach and outwash sands by lowering water levels and a lack of soil to permit vegetation growth allowed the formation of parabolic sand dunes at Carcross and at the north end of Millhaven Bay. Dunes developed in response to prevailing southwesterly winds blowing down Bennett Lake and West Arm.

Young alpine glaciers formed on north and east facing slopes above 1675 m were responsible for rejuvenating and carving out cirques and depositing morainal debris during their excavation. Cirques are well developed on most high peaks on the Montana Mountain massif and in the Bennett Range. Inactive ice sheets are exposed year-round in the headwalls of cirques on Montana and Brute Mountains and Mount Matheson.

Previous Work

The first recorded geological work in the Carcross area is that of G.M. Dawson (1889) who spent several days in the Bennett and Tagish Lake area. Exploration in the Windy Arm district at the turn of the century stimulated geological investigations by McConnell (1906) and Cairnes (1908). Cairnes engaged in geological mapping of the Windy Arm and Wheaton districts during 1909 and 1915 (Cairnes 1912, 1916). In the early 1920's, reconnaissance geological mapping was undertaken in the Whitehorse map area (105D) by Cockfield and Bell (1926, 1944). Mapping at 1:250 000 scale was begun in 1946 (Fyles 1950), continued in 1947 and completed between 1948 and 1951 by J.O. Wheeler and published as G.S.C. Memoir 312 (Wheeler 1961).

Two theses undertaken at the University of Wisconsin (Reudisili 1965, Bain 1964) examined the stratigraphy of Cache Creek Group rocks on the shores of Tagish Lake. In the early 1970's J.W. Monger undertook a regional investigation of Cache Creek Group rocks including those above Windy Arm (Monger 1975). In 1978, G.W. Morrison (1979) compiled metallogenic information on the mineral deposits of the Whitehorse area.

The most recent investigation in the area was a study of the Montana Mountain volcanic complex by C.F. Roots in 1980 (Roots 1981). Other workers have investigated the deposits of the Montana Mountain area and are mentioned later in this report.

Geological Setting

Three tectonic assemblages are exposed in the map area: Paleozoic rocks of the Atlin Terrane; Mesozoic rocks of the Whitehorse Trough which overlies Stikinia; and Cretaceous to Eocene intrusive rocks of the Coast Plutonic Complex (Figure 2). Their contacts are defined by faults or locally obscurred by younger plutons. Stikinia and Cache Creek terranes represent accreted tectonostratigraphic assemblages, and the Whitehorse Trough an overlap assemblage which overlies both terranes (Wheeler and McFeely 1987).

The Atlin Terrane (Monger 1975) forms part of the Cache Creek tectonic assemblage of Wheeler and McFeely (1987). Atlin Terrane underlies the eastern part of the map area and comprises Mississippian to Permian rocks of the Cache Creek Group. It is structurally bounded on the west and north by the Nahlin thrust fault and Crag Lake normal fault respectively (see Figure 1 for general location of faults on 105D/2). The oldest rocks of the Cache Creek Group are oceanic basic volcanic rocks and minor ultramafic rocks. These are overlain by assemblages of chert and laterally equivalent carbonate, each with associated basic volcanic rocks.

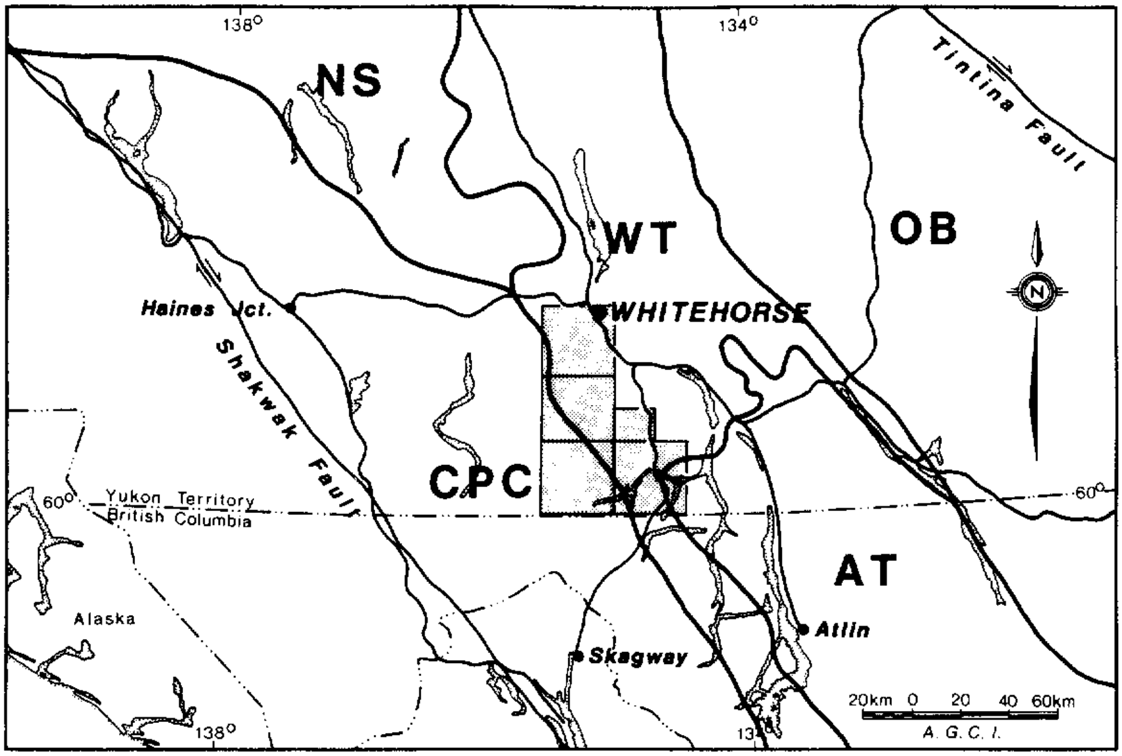

Figure 2. Tectonic elements of the southern Yukon and northern British Columbia. Project area is defined by shaded area. NS-Nisling terrane; WT-Whitehorse Trough; AT-Atlin Terrane; OB-Omineca Belt.

The Whitehorse Trough forms the northernmost extension of the Intermontane Belt of the Canadian Cordillera. It comprises an overlap sedimentary assemblage deposited on a basal island arc succession composes of marine, basic to intermediate volcanic rocks and associated sedimentary rocks of the Triassic Lewes River Group. The Lewes River Arc comprises the upper part of Stikinia, and formed near its eastern margin above a westward dipping subduction zone (Templeman-Kluit 1979, 1981). The arc assemblage is overlain by a fore-arc sequence of siltstone, sandstone and conglomerate of the Jurassic Laberge Group. Triassic megacrystic potassium feldspar-hornblende granodiorites are comagmatic(?) with Lewes River Arc magmatism.

Folding of Trough strata about north- and northwest-trending axes occurred in the Late Jurassic during response to collision of Stikinia with Ancient North America (Tempelman-Kluit 1979).

The Whitehorse Trough is bounded along its western margin by the Tally Ho Shear Zone, a 1-4 km wide zone of sheared and foliated Triassic volcanic and sedimentary rocks (Doherty and Hart 1988). The Tally Ho Shear Zone is the northern extension of the Llewellyn Fault but is more complex structurally (see Figure 1 for general location on 105D/2, D/3 and D/11).

Plutons of the Coast Plutonic Complex range in age from Middle Cretaceous to Eocene. Mid-Cretaceous to Paleocene intrusions are widespread and are biotite-bearing quartz monzonite, granodiorite and granite. They may have resulted from relaxation of the compressive stress after arc-continent collision (Tempelman-Kluit 1979). Eocene plutons occur elsewhere within the project area and are alkali enriched granite and alaskite.

Cretaceous volcanic rocks unconformably overlie all tectonic elements. The Middle Cretaceous Montana Mountain complex includes a thick lower section of intermediate flows overlain by silicic pyroclastic rocks. Late Cretaceous intermediate flows and breccia overlie folded Trough strata. These volcanic events represent the extrusive equivalents of mid- to Late Cretaceous plutons which breached the surface during the waning stages of the arc-continent collision.

Lithologic units of the map area are summarized in Table 1.

Table of Formations

ERA	PERIOD or EPOCH	FORMATION	UNIT	LITHOLOGY
CENOZOIC	Quaternary		Q	Glacial drift, aeolian sands, alluvium
	Paleocene	Carcross Pluton	$\mathbb{P}_c$	Biotite hornblende granite to granodiorite
		Finger Mtn. Pluton	T_{gr}	Granite to quartz monzonite
MESOZOIC	Late Cretaceous	Pennington Granite	LK_{gr}	Biotite hornblende granite
		Intrusive Contact		
		Carmacks Group (?)	K_r	Rhyolite and feldspar porhyry plugs
			K_v	Andesite and dacite flows, breccia, epiclastic rocks
			K_{v_1}	Dacite flows and associated pyroclastic rocks
	Unconformity			
	Middle Cretaceous	Montana Mtn. Complex	KM_{vd}	Andesite plugs
			KM_1	Rhyolite flows and pyroclastic tuff
			KM_2	Andesite and dacite flows, breccia, epiclastic rocks
			K_{gd}	Biotite granodiorite
	Early Cretaceous-Late Jurassic	Millhaven Congomerate	JK_{cg}	Polymictic pebble conglomerate
		Unconformity		
		Wheaton Valley Granodiorite	JK_{gd}	Biotite granodiorite
			M_{mz}	Pyroxene monzonite
	Jurassic		JL_{an}	Andesite porphyry
		Intrusive Contact		
		Laberge Group	JL_{cg}	Granite and volcanic cobble conglomerate
			JL_s	Feldspathic greywacke and arkose
			JL_a	Siltstone, mudstone and minor sandstone
	Triassic	Bennett Range Granite	$\bar{T}_{gr}$	Hornblende granite and granodiorite
		Intrusive Contact		
		Lewes River Group: Aksala Formation	$u\bar{T}_H$	Limestone and marble
		Lewes River Group: Aksala Formation	$u\bar{T}_A$	Andesite and dacite flows, volcaniclastic and epiclastic rocks
		Lewes River Group: Povoas Formation	$\bar{T}_P$	Basalt and basaltic andesite, augite-plagioclase gneiss
	Relations Uncertain			
	Permian (?)			Intermediate to felsic pyroclastic, basic lava flows
Fault Contact				
PALEOZOIC	Permian-Carboniferous	Cache Creek Group	CP_{ub}	Serpentinized dunite and peridotite
			CP_H	Limestone and dolostone
			CP_{Hvb}	Basalt sills and minor pillow basalt
			CP_K	Chert and minor siltstone, sandstone and limestone
	Mississippian		M_N	Metabasite and metadiorite

Table 1.

Radiometric age dating concurrent with the mapping project has resulted in revisions of age determinations for volcanic rocks and plutonic rocks across the project area. Interpretations are subject to re-evaluation as dates become available.

Acknowledgements

The authors would like to kindly acknowledge the assistance of individuals and companies working in the area. Special thanks go to Lori Walton and Dennis Oulette of United Keno Hill Mines, Ltd. for use of their contract helicopter at the Venus minesite. In addition, both openly shared knowledge and insight about the local geology. Interpretations regarding the mineralization of the Venus area further benefited through discussions with Ms. Walton.

Julie Hunt and Mark Fingland who contributed far beyond their Field Assistant status are acknowledged for capable assistance during the wettest summer on record.

Mitch Mihalynuk and Lisel Currie of the British Columbia Department of Mines, Energy and Petroleum Resources who are mapping along strike in B.C. were most helpful in sharing their data. Discussions with Al Doherty, who also administered the contract are appreciated. Nicole Hustein is thanked for enduring perpetual alterations of the maps and figures contained within this report. Roger Hulstien prepared the first draft of the mineral occurrence tables for the area.

Grant Abbott, Minerals Geologist of Exploration and Geological Services, DIAND, contributed his time, advise and ideas throughout the project and his efforts are sincerely appreciated.

LITHOLOGICAL UNITS OF THE CARCROSS AND ROBINSON MAP AREAS

ATLIN TERRANE

The Atlin Terrane occupies the eastern portion of the map area and is underlain by rocks of the Cache Creek Group. It is bounded to the north by the Crag Lake Fault and to the west by the Nahlin Fault and the Carcross pluton. All Cache Creek Group rocks exposed in the map area are part of the southwest facies belt as defined by Monger (1975).

Cache Creek rocks include 5 mappable units of three formations: Nakina, Kedahda and Horsefeed Formations (Figure 3). The Nakina Formation is composed mainly of altered basic volcanic rocks with lesser ultramafic rocks, while the younger Kedahda and Horsefeed Formations comprise chert and carbonate assemblages respectively, both with a subordinate volcanic component. The upper contact of the Nakina Formation is both gradational and intercalated with the Kedahda Formation. The Horsefeed and Kedahda Formations are recognized as facies equivalents although Horsefeed carbonate is seen unconformably overlying Kedahda Formation in the map area.

Previous workers in this area include Wheeler (1959, 1961) and Monger (1975, 1977). Recent studies on Atlin Terrane rocks in Yukon and northern B.C. have been undertaken by Bloodgood et al. (1989), Cole (1989) and Jackson and Gehrels (1989). Detailed local studies by Bain (1964) and Ruedesili (1965) include measured sections on Nares Mountain, Bove Island and on the shore west of the island.

NAKINA FORMATION (M_N)

Basaltic rocks probably correlative with the Nakina Formation are composed of massive, altered flows with lesser volcanic breccia, lithic tuff and gabbro. Alteration is variable from greenschist to amphibolite facies. Two different volcanic packages have been identified on the basis of textural and compositional variations. The first, which dominates the eastern half of the Montana Mountain massif and underlies the Mt. Nares area, is informally termed the Nares member. The second is found exclusively southwest of the Ramshorn Creek fault and is here termed the Conrad member.

Both members are composed of predominantly massive fine-grained, generally non-phyric, dark green-grey altered basalt flows and breccias. The original minerals have been almost totally replaced by a splilitic alteration assemblage of chlorite, albite, epidote and iron-titanium oxides.

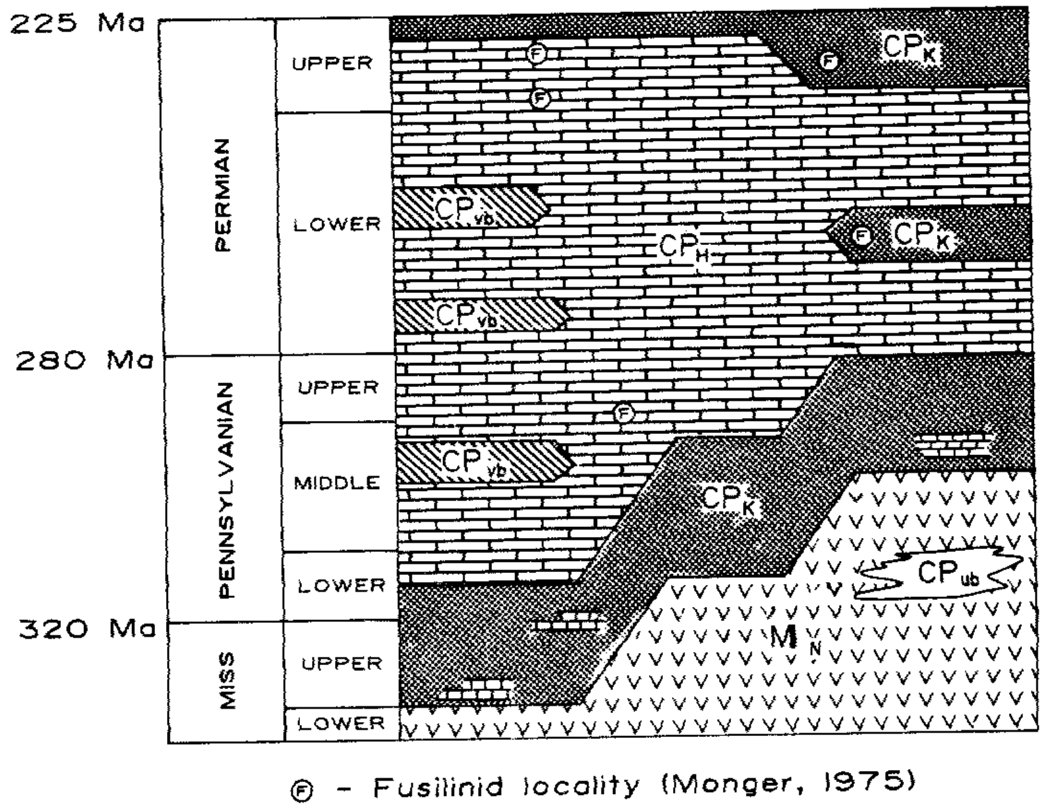

Figure 3. Schematic stratigraphic section of Cache Creek Group rocks of the Southwestern Facies Belt of the Atlin Terrane near Tagish Lake. Symbols are those used in the map legend and Table of Formations.

Nares member rocks contain thin carbonate bands and relic pillow lavas. In addition, chert horizons up to (though typically less than) one hundred metres thick are associated with these rocks on Nares Mountain and chert gradationally overlies these rocks on Escarpment Mountain. This member hosts irregular bodies of fine-grained gabbro and diorite and serpentinized ultramafic rocks. Ultramafic bodies are associated only with this member and although they often appear gradational with the volcanics, sharp contacts and local foliations indicate tectonic emplacement probably as a result of thrust faults.

The Conrad member is typically massive, unfoliated fine-grained amphibolite grading to metadiorite and metabasite. In contrast to the Nares member, it includes no sedimentary or ultramafic rocks. Outcrops are easily recognized by a reticulate geometric network of white feldspar filled fractures which intersect and cross each other with no preferred orientation (Figure 4). Thin, maroon weathering beds of lithic tuff and epiclastic siltstone define rare bedding horizons. Metamorphic grade is variable from upper greenschist to amphibolite facies and is generally higher than most rocks in the Atlin Terrane (Monger 1975).

The slightly higher metamorphic grade of the Conrad member and the lack of any significant sediments suggests that it may be older than the Nares member.

Monger (1975) suggested that volcanic rocks at Tagish Lake were probably correlative with the Nakina Formation. This assignment cannot be made with confidence since the age of the sequence is unknown, however since no other volcanic rocks older than the sedimentary formations have been identified in the southwestern facies belt, it seems likely that this nomenclature is correct. In addition, whole rock chemical analyses of volcanic rocks from the Tagish Lake area, plot near the field defined by type Nakina Formation volcanic rocks (Figure 5) of Monger (1975, 1977).

Figure 4. Reticulate network of albite (?) veinlets in Conrad member of the Nakina Formation volcanics rocks. "On the east side of Windy Arm ... is a ridge ... composed chiefly of rather fine-grained, greenish, chloritic, schistose rocks which have been much altered, and are traversed everywhere, and in all directions by a network of fine veinlets." (Cairnes 1908)

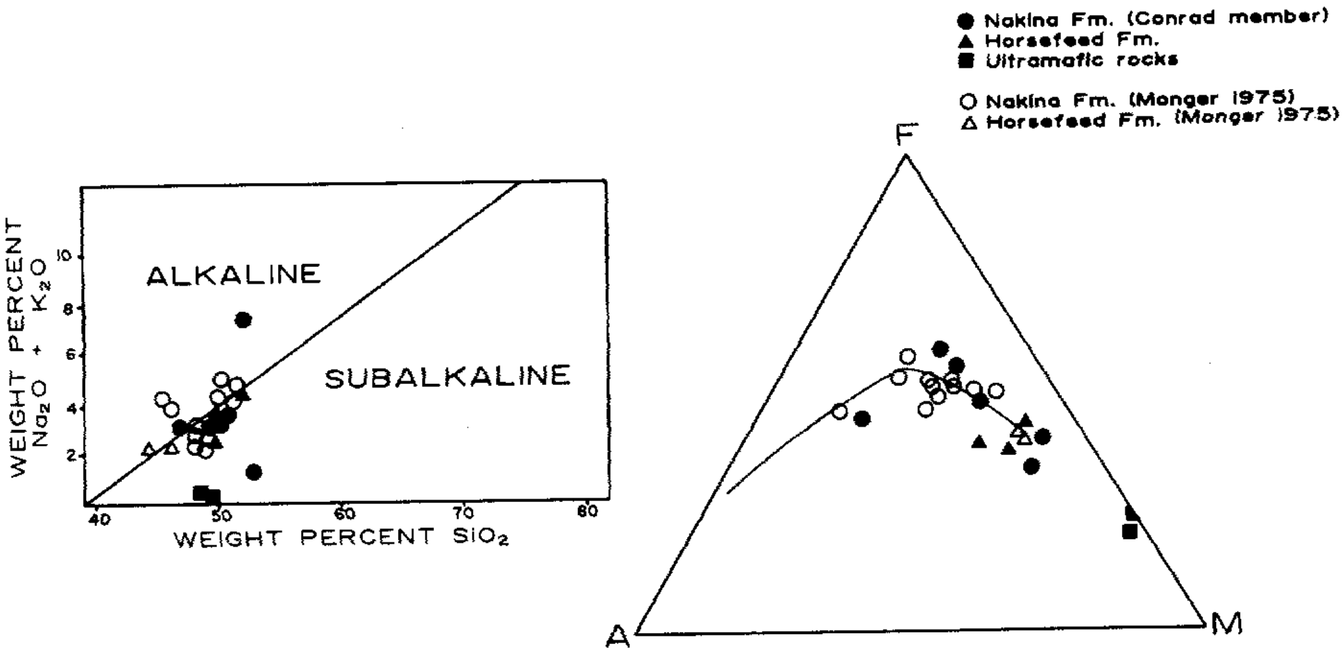

Figure 5. Chemistry of Cache Creek Group volcanic rocks from the map area compared to those of the Nakina Lake area: A) Total aklalis-silica diagram; B) AFM diagram (wt.%), A=Na_2O+K_2O, F=total Fe as Fe_2O_3, M=MgO.

KEDAHDA FORMATION (CP_K)

Chert and lesser chert breccia, siliceous siltstone, gritty chert sandstone and greywacke compose the Kedahda Formation on Escarpment Mountain and at the junction of Tagish Lake and Windy Arm. The chert is typically well bedded with an average bed thickness of 5 cm (Figure 6) Most commonly they are medium grey in colour, although brown, black, white, green, maroon and red chert are frequently encountered. Black, often fossiliferous limestone beds, rarely greater than 3 m thick, are found near the volcanic/chert contacts. Ages of the carbonate are unknown.

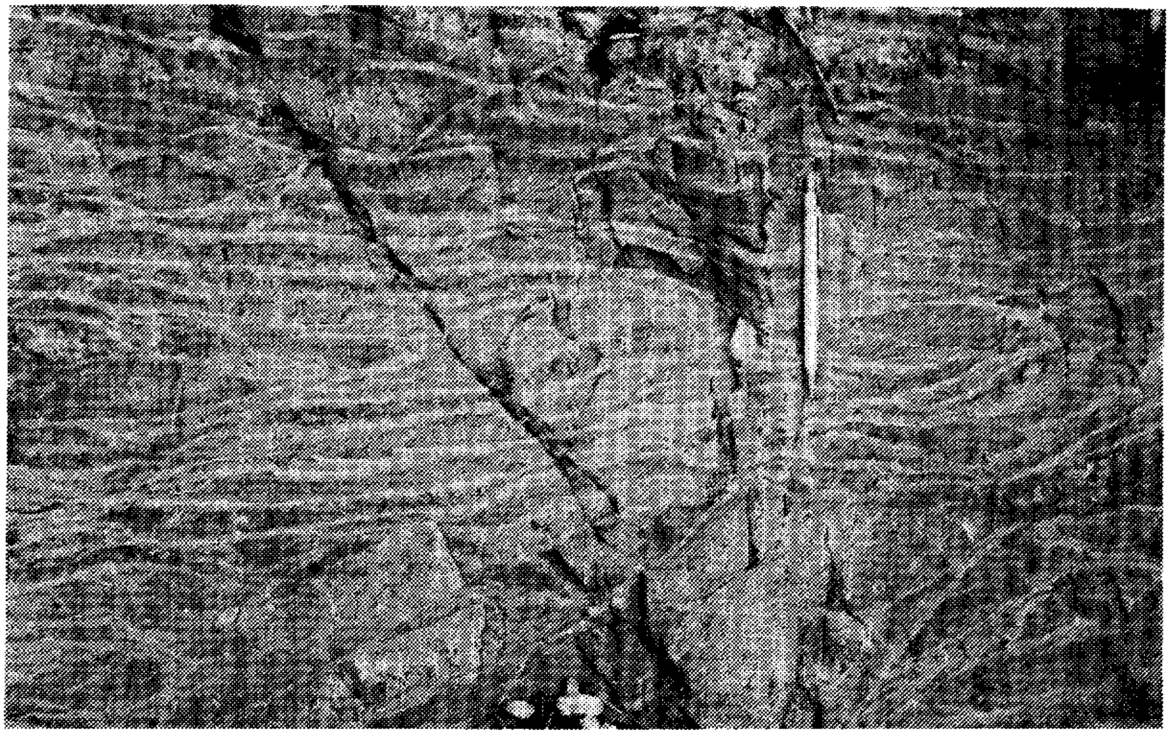

Figure 6. Kedahda Formation chert near Tagish Lake. Note the isoclinal fold axis in the centre of the photograph.

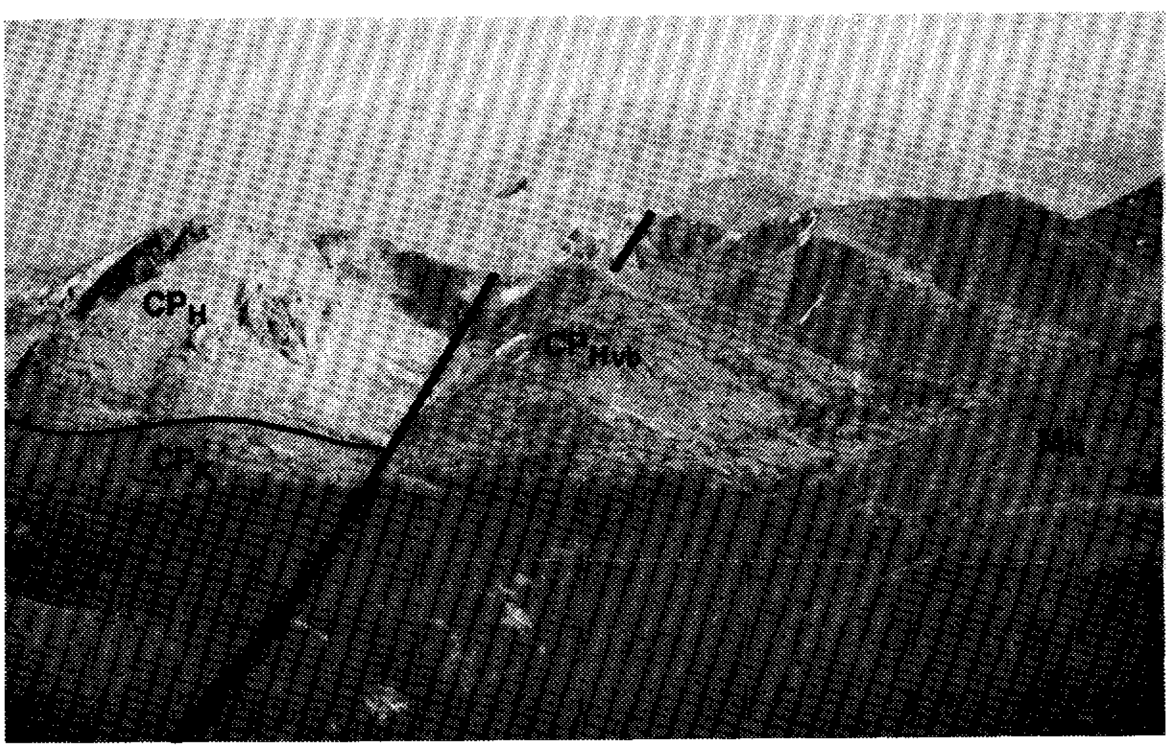

Figure 7. Looking up Ramshorm Creek at Horsefeed, Kedahda and Nakina Formation rocks of the Cache Creek Group, all in fault contact.

A lack of marker horizons and structural repetition make estimations of true thickness of the Kedahda Formation difficult. Monger (1975) suggested an apparent thickness of greater than 1500 m, but was probably referring to the central facies belt. Exposures in the map area belong to the southwest facies belt where facies equivalent Horsefeed Formation carbonate was deposited at the expense of the Kedahda Formation chert. Bain (1964) reported a measured section of chert greater than 400 m on the shore adjacent to Bove Island. An estimated thickness of 700 m is suggested for exposures in the map area.

Radiolaria have been reported in chert near Tagish Lake by Wheeler (1961). Fusilinids collected in limestone between Lime Creek and Lime Mountain (outside of the map area) by Monger (1975) returned late Early Permian and Late Permian ages.

HORSEFEED FORMATION (CP_H)

Horsefeed Formation is exposed around the junction of Windy Arm and Tagish Lake, on Bove Island and near the headwaters of Ramshorn Creek. Thicknesses have been estimated between 900 and 1500 meters by Monger (1975).

Limestone predominates with lesser calcarenite and dolomitic limestone. Most exposures are massive, recrystallized and buff yellow weathering pale grey to white bioclastic limestone. Bedding is often difficult to identify although local beds of chert, cherty calcarenite or fossil debris define bedding in some outcrops.

Crinoid, fusulinid and bryzoa fragments were commonly encountered and foraminifera, coral and oolites have been reported by Monger (1975), brachiopods by Wheeler (1961) and Ruedisili (1965). Five predominant fusulinid faunas collected by Monger (1975) range in age from Middle Pennsylvanian to Early Permian. A still earlier fusulinid age of Early Pennsylvanian was determined by Ruedesili (1965). Samples collected for conodonts by the authors have not yet been evaluated.

Outcrops of Horsefeed Formation carbonate on the shores around Bove Island are all proximal to exposures of chert. A gradational relationship was reported here by Monger (1975) who further suggested these units to be facies equivalents. Gritty chert sandstone and chert-limestone breccia at the base of Horsefeed carbonate at the head of Ramshorn Creek (Mt. White) indicates an unconformable relationship with the Kedahda chert (Figure 7).

Basic Volcanics (CP_{Hvb})

Massive, dark green basic volcanic rocks and greenstone are intercalated mainly with Horsefeed Formation carbonate but also with Kedahda Formation chert on Escarpment Mountain and at the junction of Tagish Lake and Windy Arm. Their thickness is typically less than 30 m although some exposures are up to several hundred metres thick. Most appear conformable with bedding and are often tabular, but several exposures are lenticular in section. Monger (1975) reported some tuffaceous transition zones with the enclosing country rock but none were seen by the authors.

An exposure of well formed, brown weathering pillows and tubes is found at the head of Ramshorn Creek (Figure 8) in the extreme southeast corner of the map sheet unconformably overlying Kedahda Formation chert.

Most exposures of this unit are pervasively altered to greenstone and their original mineralogy has been largely replaced by an aphanitic alteration assemblage dominated by chlorite. Dark green chlorite amygdules remain as the only recognizable primary feature. Chemical analysis indicates a basaltic composition which is chemically distinguishable from Nakina Formation rocks which are richer in iron (Figure 5).

The lack of extrusive features associated with most exposures suggests that most greenstone found in the Horsefeed and Kedahda Formations were emplaced as sills and lacoliths. This premise is supported by Cole (pers. comm., University of Arizona) in the Sentinel Mountain area where they are seen cutting mainly Middle Pennsylvanian and Lower Permian carbonate (Monger 1975) and are therefore at least as young as Lower Permian. Rocks surrounding extrusive exposures have not yet been specifically dated, and it is therefore uncertain whether these rocks were emplaced in a single event or intermittently during the deposition of the Horsefeed Formation.

ULTRAMAFIC ROCKS (CP_{ub})

Several irregular bodies of sheared or foliated serpentinized peridotite and dunite are irregularly distributed in altered Nakina volcanics on the eastern half of the Montana Mountain massif and less commonly in the Nares Mountain area. The best exposures are near Sugarloaf Hill, in roadcuts of the south Klondike Highway and one kilometre north of Montana Mountain. More bodies exist than are mapped, but their irregular and discontinuous nature make them difficult to delineate.

The ultramafic rocks form elongate bodies less than 1 km in length which trend northerly or slightly west of north parallel to their induced fabric. They vary from yellow-green to dark green, grey-blue and grey-yellow to reddish-brown in colour. Their weathered surfaces are commonly the same colour as fresh surfaces and are not usually lichen covered. Original mineralogy was mainly composed of aggregates of olivine which are now altered to serpentine antigorite, chromite and magnetite with lesser tremolite and talc. Asbestos veinlets are rare.

Figure 8. Pillow basalt overlying Kedahda Formation chert near upper Ramshorn Creek.

Exposures in the Nares Mtn. area grade into microgabbro, mafic diorite and diabase, giving the impression of a coeval or intrusive relationship with the surrounding Nakina volcanics. Sugarloaf Hill exposures are more severely sheared near a fault and may therefore have been emplaced tectonically. The Montana Mountain ultramafic body has many atypical characteristics which have been described by Wheeler (1961) and Roots (1982). It is irregularly shaped and is bounded between granite and metamorphosed sediments. It seems that this body is a huge xenolith, rafted on the intruding granite (Roots; written comm. 1988) and wasn't assimilated because of the higher melting temperature of the mafic mineral assemblage.

Ultramafic rocks in the Nakina Formation may be as old as Mississippian. Radiometric and paleontological ages of rocks associated with ultramafic bodies have returned Late Mississippian ages. Near Atlin, ultramafic rocks mapped by Bloodgood et al. (1989), are at least as young as the Permian strata they intrude. Ultramafic rocks in the Atlin Terrane are therefore considered to be Carboniferous to Permian in age.

PALEOZOIC VOLCANIC ROCKS (P_{vs})

Resistant, dark grey weathering, moderately bedded, variably sheared and foliated intermediate to felsic pyroclastic rocks, basic lava flows, lithic greywacke, angular pebble conglomerate, hornfels and rare green pyroxenite outcrop in the Bennett Range near the B.C. border.

Somewhat of an enigma, these rocks are unlike Lewes River lithologies in that they contain a significant componant and lack augite-phyric volcanic rocks. While variably foliated and altered, they are unlike higher grade rocks mapped as HCsn by Doherty and Hart (1988), previously described by Wheeler (1961) and recently described as the Nisling assemblage by Erdmer (1989).

Exposures are intruded by plutonic rocks assumed to be Late Triassic in age and are unconformably overlain by rocks of the Jurassic Laberge Group. The Bennett Range exposures were mapped in British Columbia as belonging to the Boundary Ranges Metamorphics (equivalent to Nisling assemblage) by Mihalynuk and Rouse (1988). Similar rocks recognized by Mihalynuk et al (1989) near Racine Lake, are in fault contact with Stuhinni Group (Lewes River equivalent) rocks and were loosely correlated with them. Mihalynuk (pers. comm., 1989) has confirmed the similarity of the Bennett Range and Racine Lake rocks and believes they are part of the same package.

These rocks maybe older than Late Triassic but are younger than Proterozoic to Paleozoic(?) Nisling assemblage (Boundary Ranges Metamorphic) rocks. The

These rocks maybe older than Late Triassic but are younger than Proterozoic to Paleozoic(?) Nisling assemblage (Boundary Ranges Metamorphic) rocks. The authors concur with Mihalynuk (written comm. 1989) that this unit may be correlative with either the 'western facies' of the Stuhini Group or Lower Permian rocks of the Stikine Assemblage. Both have been described by Anderson (1989) in the Iskut area of northern B.C..

WHITEHORSE TROUGH

LEWES RIVER GROUP

Rocks of the Lewes River Group represent a Middle to Late Triassic volcanic and sedimentary island arc assemblage which forms basement to the Whitehorse Trough. It has been stratigraphically divided into the Aksala and Povoas Formations by Tempelman-Kluit (1985). The Povoas Formation includes predominantly massive, basic volcanic rocks which are overlain by volcaniclastic and sedimentary rocks of the Aksala Formation. The Aksala Formation has been further divided into the Annie, Hannock and Mandanna members. The Mandanna member is not exposed in the map sheet, and is therefore not described here.

Stratigraphic sections rarely include all units of the Lewes River Group as a result of lateral and vertical facies changes (Figure 9). In general, volcanic rocks of the Lewes River Group are thickest along the western margin of the Trough and apparently thin in an eastward direction (Wheeler 1961).

POVOAS FORMATION (Carnian and older?)

The Povoas Formation, the oldest member of the Lewes River Group, is composed of basic lava flows with associated volcanic breccia, epiclastic rocks and volcanogenic sandstone. The base of the formation is nowhere exposed in the map area, and it ranges in thickness up to 6000 m. It is divided into three lithologic units comprising mainly massive greenstone, augite porphyry, or their metamorphic equivalents.

Massive Greenstone Unit (Tr_p)

The massive greenstone unit is composed of undifferentiated basalt and basaltic andesite flows with intercalated agglomerate, volcanic breccia, epiclastic rocks and minor tuff. The flows are massive, light to dark green and maroon coloured and aphanitic or sparsely porphyritic. Phenocrysts are euhedral augite (5-15%) and plagioclase (5-10%), and range in size from 0.5-1.0 cm. Breccia occurs locally and forms massive, irregular to lenticular shaped beds composed of 35-70% subangular to angular volcanic fragments which average 1 to 10 cm, but may be up to 30 cm in diameter. The groundmass is aphanitic, green or maroon coloured and similar in composition to the flows in which they are incorporated. Breccia is interpreted to represent both massive flow breccias and slightly reworked epiclastic material. Thin to medium bedded greywacke and green airfall tuffs occur rarely in the section.

Thin intervals (2-20 m) of massive limestone and thin bedded calcilutite occur in massive basalts on the east side of Mount Grey.

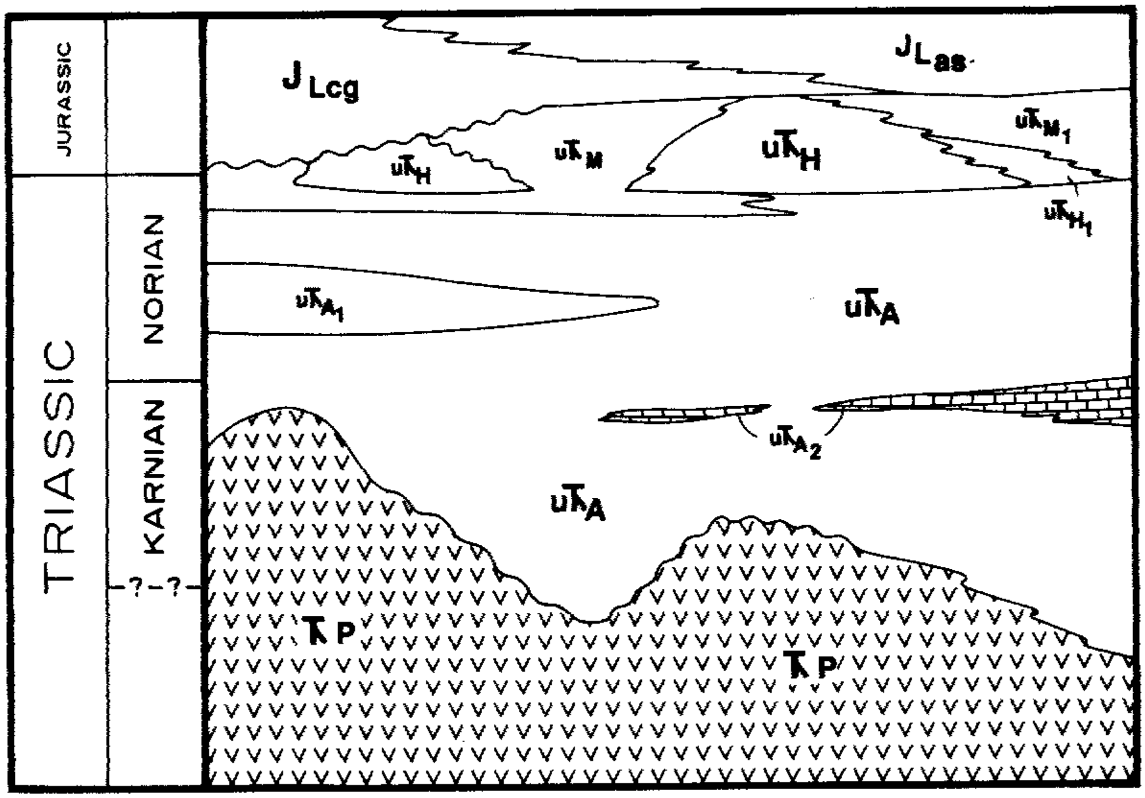

Figure 9. Schematic stratigraphic section of the Lewes River Group identifying its facies relationships between its members, and with Laberge Group rocks.

Augite Porphyry Unit (Tr_{P1})

Massive, dark green to black augite porphyry basalt flows occur on Mount Grey, near Knob Hill and on Dundalk Mountain. Augite phenocrysts (0.5-2.0 cm) typically comprise from 15-25% of the rocks composition but may compose up to 70%. The groundmass is typically aphanitic but locally contains fine-grained euhedral plagioclase crystals. The crystal-rich pyroxene porphyries are probably subvolcanic intrusive equivalents of the flows although crosscutting relationships were not observed.

Sheared Metabasite Unit (Tr_{Pm})

Variably foliated to mylonitic, upper greenschist facies, metamorphic equivalents of Tr_P and Tr_{P1} are composed of chlorite-pyroxene and chlorite schist, pyroxene-plagioclase gneiss and minor metasedimentary rocks. They are restricted to the Tally Ho Shear Zone along the western part of the map area. Deformation of this unit is inhomogeneous at all scales. The foliation fabric is most pervasive near fault contacts with intrusive rocks of the Coast Plutonic Complex along the western boundary of the Tally Ho Shear Zone. Gneissic compositional layering and mineral alignment are well developed textures in the most intensely deformed rocks. Compositional layering is defined by alternating plagioclase and pyroxene rich layers, and the mineral alignment fabric by prismatic augites in medium- to coarse-grained pyroxene-plagioclase gneiss. Fine-grained mafic layers are typically replaced by chlorite or epidote.

AKSALA FORMATION

ANNIE MEMBER (Carnian to Norian)

The Annie member is a new member proposed by the authors to differentiate coarse volcaniclastic rocks from finer-grained marine sediments of the Mandanna member. It disconformably overlies the Povoas member in the western part of the Whitehorse Trough. The member is best exposed on Needle Mountain where it is approximately 1000 m thick.

Volcaniclastic Unit (uTr_A)

The volcaniclastic unit comprises mainly volcaniclastic pebble conglomerate and breccia intercalated with lithic arenite and minor airfall tuff. Conglomerate and breccia are massive to poorly bedded and are typically matrix supported but locally clast supported. The clasts are subangular to rounded and make up 40-75% of the rocks composition. They are composed of augite porphyry, subvolcanic dacite porphyry and minor aphanitic volcanic and sedimentary rock fragments; the volcanic fragments where derived from the underlying Povoas Formation or from laterally equivalent lava flows. The matrix is composed of crystal-rich greywacke and arenite.

These rocks are thought to represent mainly epiclastic material and debris flows, but also synvolcanic agglomerate derived from nearby volcanos.

Volcanogenic breccia and conglomerate grade laterally into, or are interbedded with, immature massive to thick bedded, medium to coarse-grained, red and grey lithic arenite. The framework comprises mainly volcanic lithic fragments and pebbles and plagioclase feldspar. On Needle Mountain these overlie an irregular surface of Povoas Formation basalts and contain abundant trough cross bedded sandstone beds and pebble-rich layers which show scoured lower bedding surfaces.

Andesite Flows (Tr_{A1})

Northwest of Watson Ridge on the Robinson map sheet, massive andesite flows overlie crystal-rich arenite and underlie massive limestone. The flows are dark green to red and plagioclase (10-15%) porphyritic.

Limestone Unit (Tr_{A2})

On Needle Mountain and south Grey Ridge, lenticular white to grey, fine-grained, massive limestone and marble occurs near the base of the section. The unit is approximately 30 m thick and almost totally recrystallized.

HANCOCK MEMBER (Norian)

The Hancock member conformably(?) overlies the Annie member on the east slopes of Mount Gilliam and the Povoas member east of Bennett Lake. It is divided into two units of massive limestone and interbedded limestone and siltstone.

Massive Limestone Unit (uTr_H)

White to grey weathering, massive limestone is the most common lithology of this unit. East of Grey Ridge it is several hundred metres thick and laterally extensive, and in MacDonald Creek east of Bennett Lake it thins to approximately 100 m. It is typically recrystallized to fractured, medium to coarse-grained marble in which no primary structures are preserved. Conical shaped stromatilites were found at one location, east of Bennett Lake.

Limestone and Siltstone Unit (uTr_{H1})

Interbedded limestone and argillaceous siltstone occur north of MacDonald Creek. Massive limestone intervals range from 5 to 40 m, and siltstone from 1-10 m. The argillite is pyritiferous, rusty weathering, dark grey to green coloured and thin bedded to laminated.

Farther south, in the upper reaches of Knob Creek, this unit is represented by a thin, 1 m thick dark grey gritty bed of calcareous greywacke.

Age and Interpretation

The Lewes River Group has returned fossil ages of Carnian to Sinemurian (Wheeler 1961, Reid and Tempelman-Kluit 1987, Tempelman-Kluit in press, Doherty and Hart 1988).

The volcanic and sedimentary rocks of the Lewes River Group represent an island arc assemblage and its erosional equivalents. The base of the arc succession is not reported in the Whitehorse Trough.

Povoas Formation basalt, although laterally extensive along the western part of the map area, lack any internal structures such as bedding or pillows. Thin interflow carbonate horizons in fine-grained basalts on Pyramid Mountain suggests they were deposited in a shallow marine environment. Flow breccia and debris flows occur on Knob Hill, and may indicate of greater relief. Coarse-grained, crystal-rich pyroxene porphyryies may be largely intrusive.

Map relationships suggest that the Povoas Formation was eroded prior to deposition of the overlying Annie member. On Needle Mountain, cross-bedded and pebbly sandstone fill channels on the irregular Povoas surface. The Annie member is locally hundreds of metres thick but is discontinuous and typically pinches out along strike, suggesting it may have filled topographic lows. Limestone units near the base of the member show that the environment was gradually submerged, if not initially.

Carbonate deposition eventually dominated in the uppermost Aksala Formation as a result of decreased detrital input. Hancock member limestone shows a pronounced northward thickening, and in the Macdonald Creek area thins rapidly southward from hundreds of metres to a few tens of metres in less than 2 km. Thin limey clastic rocks further south suggest the area was near shore and drowned in terrestrial clastics, in contrast to the carbonate shelf environment to the north.

LABERGE GROUP (Hettangian to Aalenian)

Lower and Middle Jurassic Laberge Group are exposed north of the Crag Lake Fault and in the upper drainages of Dundalk, Knob and Wynton Creeks. Smaller exposures are located southwest of Pyramid Mountain and between Sugarloaf Hill and Montana Creek.

Sedimentary rocks of this unit are divisible into three units: polymictic cobble conglomerate; greywacke and arenite; and argillite, siltstone and hornfels. A section on the west slope of Brute Mountain measured by Wheeler (1961) has a minimum thickness of 1600 m. The contact with the underlying Lewes River Group is mainly conformable, but the stratigraphic relationship varies due to facies changes. The units interfinger and grade into one another reflecting lateral and vertical facies variations that characterize the depositional history of the Laberge Group.

Rocks of the Laberge Group conformably overlie those of the Lewes River Group. The contact is represented by the top of the uppermost carbonate unit in the Hancock member which is well developed in most areas. South of Brute Mountain the contact is poorly developed and is represented by a 1 m thick bed of limey greywacke upon which similar looking, but non-limey greywacke and conglomerate of the Laberge Group is deposited.

CONGLOMERATE UNIT (J_{Lcg})

The unit comprises polymictic cobble conglomerate intercalated with thin arenite and greywacke layers (Figure 10). It forms massive lenticular units (up to 200 m thick) in argillite sections on Brute and Caribou Mountains. Conglomerate beds, often less than 10 m thick are traceable for several kilometers along strike, and the base of conglomerate beds are often scoured or contain rare large scale trough cross-beds. On Caribou Mountain the conglomerate unit also forms massive sections several hundreds of metres thick.

Conglomerate typically forms well indurated steep sided, hummocky outcrops with distinctive rusty orange weathering surfaces. It is green-grey coloured, thick-bedded to massive, poorly sorted and both clast and matrix supported. The matrix is composed of immature, medium to coarse-grained feldspathic arenite and greywacke.

Clasts are sub- to well-rounded, range from 60% to 85% in abundance and from 1 cm to up to 50 cm (average 8-15 cm) in size. Granite and volcanic rocks are the most common, including aphanitic to feldspar porphyritic andesite, crystal-rich dacite, biotite and biotite hornblende granite and granodiorite, leucogranite and quartz diorite. The abundance of intrusive clasts increases upsection, and comprise up to two-thirds of the clast population. Sedimentary rock fragments are less abundant and include greywacke, siltstone, quartzite and rare chert.

Large (0.5 m), angular limestone fragments compose up to 25% of Laberge conglomerate clasts near Caribou Mountain and were probably derived from the upper Lewes River Group, but possibly from Horsefeed Formation of the Cache Creek Group. The resultant unconformity is not exposed.

SANDSTONE UNIT (J_{Ls})

On the slopes east of Bennett Lake and north of Crag Lake, massive, lenticular layers (20-100 m) of immature, feldspathic greywacke and arenite are intercalated with thick argillite sections. The sandstone also forms aerially extensive beds greater than 300 m on western Caribou Mountain.

Figure 10. Sharp-based, massive, polymictic Laberge Group conglomerate on massive arkosic sandstone, near Caribou Mountain.

Most sandstones are medium to thick bedded or massive, medium to coarse-grained, dark grey coloured and poorly sorted. Rare outcrops are well sorted and contain bedding with magnetic layers. The framework is composed of angular to subrounded feldspar (35-60%), quartz (5-15%), lithic fragments (10-30%) and oxidized mafic minerals (5-10%). The matrix is composed of aphanitic to very fine-grained chlorite and white mica. Pebbly sandstone intervals are common, and contain between 10-35% subangular to rounded volcanic, chert and other sedimentary rock fragments.

ARGILLITE UNIT (J_{La})

The argillite unit is composed of interbedded argillaceous mudstone, siltstone and minor fine-grained sandstone. It forms thick successions on the high standing ridges east of Bennett Lake and on Caribou Mountain, and ranges in thickness from 100 m to at least 800 m. A thin (3 m) bed of fossiliferous limestone exposed on the west slopes of Caribou Mountain is probably equivalent to a similar bed on Idaho Hill (Wheeler 1961, Doherty and Hart 1988).

The argillite is dark rusty red-brown weathering, light to dark grey and green coloured, generally siliceous and contains abundant ammonites. Intercalated sandstone is composed primarily of fine-grained quartz and minor feldspar. Mudstone and siltstone beds range in thickness from <1 cm to 4 cm, and sandstones from 1-2 cm. Primary structures are well exposed in hornfelsed sections, and include ripple laminations, starved ripples, graded bedding, pinch and swell structures and soft sediment deformation. Graded, alternating arenite-mudstone couplets commonly form sections hundreds of metres thick.

On the southern slopes of Caribou Mountain, north of the east-trending Crag Lake Fault, the unit comprises resistant, grey and brown, finely laminated phyllite (J_{Lm}). Bedding and cleavage are predominately east to northeast trending along closely spaced parallel fold axis, slightly oblique to the trend of the fault. On the ridge north of Crag Lake, intercalated conglomerate contains flattened fragments whose elongation direction parallels the foliation fabric. Sandstone in the phyllite unit contains fine-grained white mica along fracture surfaces.

Age and Interpretation

Ammonites collected in the Whitehorse map area by Wheeler (1961) range from earliest Jurassic to early Middle Jurassic in age. Equivalent Inklin facies rocks in northern B.C. contain Pleinsbachian (Bultman, 1979) and Toarcian (Mihalynuk and Rouse 1988) ammonites. Reid and Tempelman-Kluit (1987) report Laberge Group fossils ranging from Sinemurian to Aalenian in age.

The Laberge Group was deposited in a variety of environments characterized by lateral and upsection facies changes. As a result, the contact between the Lewes River and Laberge Groups is facies controlled and therefore isn't everywhere represented by the same lithological sequence. In the map area the contact is apparently conformable.

Conglomerate was deposited as coelessing marine fanglomerate and debris flows with lesser deposits in alluvial bars and submarine channel complexes as indicated by planar tabular cross-bedding and extensively scoured bases respectively. Massive feldspathic greywacke and sandstone were deposited basinward and above the fan complexes. Low angle and planar stratified sandstone occasionally contains magnetite horizons indicative of beach facies. Deep water, graded sandstone-mudstone couplets are representative of Bouma BC(E) turbiditic sequences (Dickie 1988a) deposited in distal environments.

Distal and vertical facies relationships are well documented in the Brute Mountain section where individual, sheet-flood, channel and debris flow conglomerate beds thin northeasterly and are interbedded with and replaced distally by greywacke. Dickie (1988b) has interpreted this section as a sequence or stacked channels.

The progressive vertical increase in granitic clasts is representative of deeper erosion of the source arc. The high degree of rounding and spherocity of the clasts probably took place in braided fluvial systems subject to periodic flooding. This flooding may have acted as the triggering mechanism for the massive debris flow conglomerate and greywacke.

PORPHYRITIC ANDESITE (J_{Lan})

Small, hypabyssal bodies of drab, olive green-grey andesite porphyry intrude Jurassic Laberge Group rocks and Triassic(?) granodiorite on the eastern slopes of the Bennett Range near the B.C. border. The exposures are rusty weathering due to alteration during emplacement of younger plutons.

Plagioclase occurs as 6 mm equant phenocrysts and compose up to 30% of the rock volume. Acicular hornblende phenocrysts are common.

The unit resembles porphyritic andesite flows found in Laberge Group strata in the Wheaton River area as described by Doherty and Hart (1988). Flows of probable Late(?) Cretaceous age on Grey Ridge are also similar.

Age and Interpretation

The unit is younger than the Jurassic Laberge Group which it intrudes and older than the Finger Mountain granite (T_{gr}) presumed to be Paleocene, which cuts it. Mihalynuk and Rouse (1988) consider these rocks to be intrusive equivalents of Middle and Upper Jurassic volcanic rocks (muJ_v) overlying Laberge Group. These rocks may also be intrusive equivalents to Late Cretaceous volcanic rocks found on Grey Ridge.

MILLHAVEN CONGLOMERATE (JK_{cg})

Clast-supported, immature, polymictic, angular pebble conglomerate of uncertain age occurs in several locations on the slopes west of the Wheaton River. It is composed of quartz-mica schist and granite gneiss with lesser rhyolite, andesite, quartzite and metamorphic quartz clasts. Exposures are proximal to and probably unconformably overlie Lewes River Group rocks.

Poorly indurated conglomerate exposed near Millhaven Bay and in the lower Wheaton River valley are light grey weathering granular, tawny coloured aggregates of sub-rounded metamorphic and quartz clasts in a mica and feldspar matrix. A similar rock has been identified on the western slopes of the Bennett Range (T. Garagan pers. comm. 1988; INAC 1988, p. 114-116).

Exposures near Dickson Hill are purple to dark red weathering, well indurated and contain distinctive red or pink metamorphic quartz clasts. They are similar to conglomerate mapped by Doherty and Hart (1988) as part of the Laberge Group on Chieftain and Dickson Hills. Mihalynuk and Rouse (1988) and Mihalynuk et al. (1989) have described similar rocks (PT_c and M_{vb} respectively) as a basal conglomerate which sits unconformably on Nisling assemblage metamorphic rocks In northern B.C. they are overlain by undated (probably mid- or Late Cretaceous) Teepee Peak volcanic rocks and possibly (although in a structurally complex area) Jurassic Laberge Group.

Contact relationships suggest that this unit represents a basal conglomerate deposited during an erosional epoch prior to the deposition of the Teepee Peak volcanics and possibly before Laberge Group deposition. Therefore, the age of this unit is not well defined. An erosional epoch spanned the period from upper Middle Jurassic until the deposition of the Tantalus formation in the Cretaceous.

CRETACEOUS VOLCANIC ROCKS

MONTANA MOUNTAIN VOLCANIC COMPLEX

The Middle Cretaceous Montana Mountain volcanic complex is located in the southcentral part of the Carcross map area, and extends southward into northern BC. It forms an isolated, elongate area approximately 80 km^2, comprising mainly greenschist facies intermediate lava flows, volcanic breccias and epiclastic rocks. In the north and central parts of the complex the succession also contains minor interbedded silicic flows and pyroclastic tuffs, while in the south silicic volcanic rocks predominate. The complex is structurally bound on all sides excepting an intrusive contact with the Carcross Pluton on the north. Normal faults juxtapose volcanic rocks against older Laberge Group sedimentary rocks on the west, south and northeast margins (Roots 1981). The north-trending Nahlin Fault juxtaposes Carboniferous-Permian Cache Creek Group against the east side of the complex.

The Montana Mountain complex is correlated with the Mt. Nansen Group (Roots 1981), and is divided into three units on the basis of composition and in part by mode of emplacement. These include intermediate flows and breccias, silicic flows and pyroclastic tuffs, and andesite plug domes. All units are cut by younger rhyolite dykes thought to be related to the Carcross pluton.

The oldest(?) unit (K_M1) consists of intermediate lava flows and extensive volcanic breccias of similar composition. It is the most laterally extensive unit within the complex and varies significantly in compositional character. Volcanic breccias predominate on Montana Mountain and Mount Matheson in the north, whereas on Dail Peak in the central part of the complex the succession comprises massive intermediate lava flows and minor interbedded felsic flows and pyroclastic rocks (1200 m, Roots 1981). In general, the unit includes approximately equal amounts of lava flows and volcanic breccia.

Lava flows consist of massive to poorly bedded andesite and dacite. Bedding is recognized only where flow top breccias are preserved. Both andesite and dacite flows are generally aphanitic, dark to light green coloured and may contain 5-15% subhedral to euhedral feldspar phenocrysts (2-10 mm). Dacite flows also contain 2-5% anhedral quartz phenocrysts (3-5 mm). At the southern base of Dail Peak, lava flows contain between 5-15% spherical to elongate, very fine-grained, intergranular chlorite and calcite amydules (0.5 to 1.5 cm).

Lapilli tuffs are locally interbedded with massive lava flows, commonly in the northern part of the complex. Tuff horizons range in thickness from less than 1 m to up to 15 m, and are composed of 15-30% angular to irregular, whispy shaped andesite clasts (1-5 cm) in an aphanitic matrix of similar composition. The clasts are thought to be primary volcanic clasts contemporaneous with the flows. Thin bedded, light green air fall tuff intervals, ranging in thickness from a few centimeters to up to 2 m, are also locally interbedded with the flows.

Breccias form massive, laterally extensive units which are either interbedded with massive lava flows or else form massive, irregular shaped units tens of metres to hundreds of metres thick which typically pinch out rapidly along strike. The breccias are both monolithic and heterolitic, and are composed of 60% and 85% lithic fragments in an aphanitic to fine-grained matrix. The clasts are angular to rounded, and range in size from 1-30 cm with an average size of 3 cm. They are composed predominantly of intermediate volcanic rocks; minor sedimentary and intrusive rock fragments occur locally. The monolithic breccia beds commonly contain volcanic clasts rimmed by aphanitic, darker coloured material, which may represent either rapidly chilled primary volcanic ejecta or else accidental or primary lava fragments which were coated by ash material during eruption. They are interpreted as volcanic bombs incorporated in mainly explosion breccias, and also autoclastic breccias associated with the flows. Heterolithic breccias may be either debris flows or epiclastic in origin.

Rhyolite flows, pyroclastic tuffs and minor volcanic breccias are designated to a second unit (K_{M2}), which is most prominent in the southernmost extension of the complex, southeast of Windy Arm and in northern B.C. (Milhalynuk et al. 1988).

On Montana Mountain in the northernmost part of the complex, a massive rhyolite breccia of uncertain thickness and limited lateral extent is isolated in an area of massive andesite and lapilli tuffs. The breccia is composed of 30-45% angular silicic volcanic fragments (1-15 cm) in an aphanitic white to light green, vitric groundmass which has been recrystallized. Overburden limits exposure and contact relationships are obscured.

Near Dail Peak, at least 1200 m of predominantly andesite flows are intercalated with silicic units along the south facing cliffs and the high standing ridges. The lower units are composed of lenticular, dark to light green pyroclastic tuffs ranging in thickness from 50-300 m. They are weakly porphyritic to crystal-rich and contain between 5-10% quartz (2-3 mm) and 10-15% feldspar phenocrysts (1-5 mm), including both sodic plagioclase and potassium feldspar. Light green to pink, rusty orange weathering, locally flow banded rhyolite occurs on the ridge tops, and thickens from 50 m to at least 250 m from north to south. They are generally aphanitic but may contain minor (< 10%) quartz and feldspar phenocrysts. The flow unit thickens and grades laterally eastward to autoclastic breccia.

Southeast of Windy Arm, approximately 700 m of intercalated, shallowly dipping pyroclastic tuff and pale orange, flow banded rhyolite predominant. The flows unconformably overlie altered, dark green volcanic breccia probably belonging to the Lewes River Group.

Resistant, massive dark green, aphanitic to sparsely plagioclase porphyritic andesite plug domes (K_{Mvd}) form high standing units along the western margin of the complex. They are intrusive in nature and commonly contain numerous inclusions along their margins giving rise to monolithic or unusual heterolithic breccias.

Alteration

The volcanic rocks are everywhere weakly to intensely propyliticly altered, and are also locally weakly foliated. In thin section, plagioclase phenocrysts are everywhere seen to be completely replaced by sericite. The groundmass is composed of dispersed microcrystalline plagioclase and mafic minerals in a fine-grained, mottled mass of microcrystalline chlorite, epidote and/or calcite . Mafic minerals are completely replaced by chlorite and oxide minerals. Pervasively altered flows are replaced by chlorite and epidote stringers which may comprise between 15-70% of the rock. The rocks on the southern part of Dail Peak also have a closely spaced cleavage fracture.

Structure

Faults associated with volcanic events in the Montana Mountain volcanic complex are difficult to recognize due to the lack of laterally extensive marker horizons and identifiable stratigraphy. Most faults associated with the complex are younger and related to its subsidence or the subsequent intrusion of the Carcross Pluton.

The Wynton Creek and Dail Peak faults downdrop the Montana Mountain complex to its present position. Total vertical displacement of the faults are in the order of 1500 m. Similar faults exist along the western limit of the complex but appear to have been modified by the emplacement of the Carcross Pluton. The eastern margin of the complex with Laberge Group rocks is poorly exposed and has been annealed (hornfelsed), but is unconformable (Roots 1981).

The emplacement of the Carcross Pluton resulted in a significant vertical uplift of the northern portion of the complex (Roots 1981), and reactivation of older bounding faults.

A well developed fracture cleavage in rocks adjacent to the Wynton Creek and Dail Peak faults, and the displacement of the Lewes River/Laberge Group contact suggest dextral transcurrent reactivation during post mid-Cretaceous time. Similar stresses may have been responsible for other strike-slip faults in Laberge and Lewes River Group rocks on the western flanks of Brute Mountain.

Age and Interpretation

Two concordant zircon U-Pb age dates of 94 Ma have been obtained from a felsic pyroclastic horizon near the head of Pooly Creek (Armstrong pers. comm. 1989). Potassium-argon dates of 95 and 99 Ma (Armstrong) indicate that despite the intrusion of the Carcross Pluton the dates have not been reset. A zircon Pb-U date at 88 Ma (Armstrong pers. comm. 1989) from flow banded rhyolite west of Old Lady Lake probably represents the youngest volcanic event.

The Montana Mountain Complex forms an isolated, fault bonded volcanic remnant of predominantly intermediate lava flows and breccias, and less abundant felsic volcanic rocks. The volcanic environment which existed during its formation was complex and is difficult to reconstruct due to discontinuity of the belt, and of exposure. The abundance of volcanic breccias debris flows and epiclastic breccias suggests topographic relief and proximity to vents. Abrupt thickening and brecciation of the felsic flows on Dail Peak may be due to ponding of lava in a depression or valley, and fragmentation due to rapid chilling at the surface as the flow continued to move, possibly due to contact with water. The absence of interflow sediments suggests the volcanos were forming in a subaerial depositional environment but local streams or lakes may have existed.

With the possible exception of the rhyolite breccia unit on Montana Mountain, the authors do not concur with Roots (1981) that the breccia in the north represent intrusion breccias. Current mapping shows that these breccias are interbedded with massive lava flows and lapilli tuffs, and therefore have stratigraphic rather than intrusive contacts.

Whether the silicic volcanic rocks in the southern part of the complex represent lateral equivalents of intermediate volcanic rocks in the north, or whether the silicic volcanic rocks increase upsection remains uncertain. On the basis that the intermediate lava flows and breccias and silicic pyroclastic tuffs represent contrasting styles of volcanism, the latter possibility is here considered a more feasible interpretation. Stratigraphic relationships indicate that silicic volcanics were deposited at greater distances from volcanos and onlapped Lewes River Group in the southern part of the complex. Uplift of the northern part of the complex is thought to have been accomplished through normal faulting during emplacement of the Carcross Pluton.

The transition from strato volcanos composed of intermediate lava flows to thick accumulations of pyroclastic tuff is common in evolving caldera type volcanic centres (Fisher and Schmincke 1984). On the premise that the silicic volcanic rocks represent the youngest part of the section, the Montana Mountain complex is interpreted as the roots of an eroded caldera (Roots 1981).

CARMACKS GROUP

CRETACEOUS VOLCANIC ROCKS (K_{v1})

Dark grey to black, massive to thickly bedded, fine-grained to porphyritic andesite and dacite flows, lapilli tuff and lesser epiclastic sediments are exposed on the extreme northern end of Mount Stevens. These are part of a larger belt of volcanic rocks which outcrop on Wheaton, Folle and Bush Mountains.

The origin of these rocks is somewhat enigmatic. They are notably dissimilar to volcanic rocks exposed on Grey Ridge or Montana Mountain. On Mount Stevens they are faulted against the Wheaton valley granodiorite. North of the Wheaton River, they appear to have been deposited on the Wheaton Valley granodiorite and then cut by the Perkins Peak plug, which is probably Paleocene in age. This loosely confines these rocks to a Cretaceous age.

LATE(?) CRETACEOUS VOLCANIC ROCKS (K_V)

The unit is restricted to Grey Ridge on the Robinson map sheet. It forms high standing ridges of flat lying to gently dipping volcanic strata which unconformably overlie folded Whitehorse Trough strata (Figure 11). The sequence is cut by the Paleocene Carcross Pluton on the south. The unit underlies an area approximately 30 km^2, and ranges in thickness from 200 m to at least 600 m.

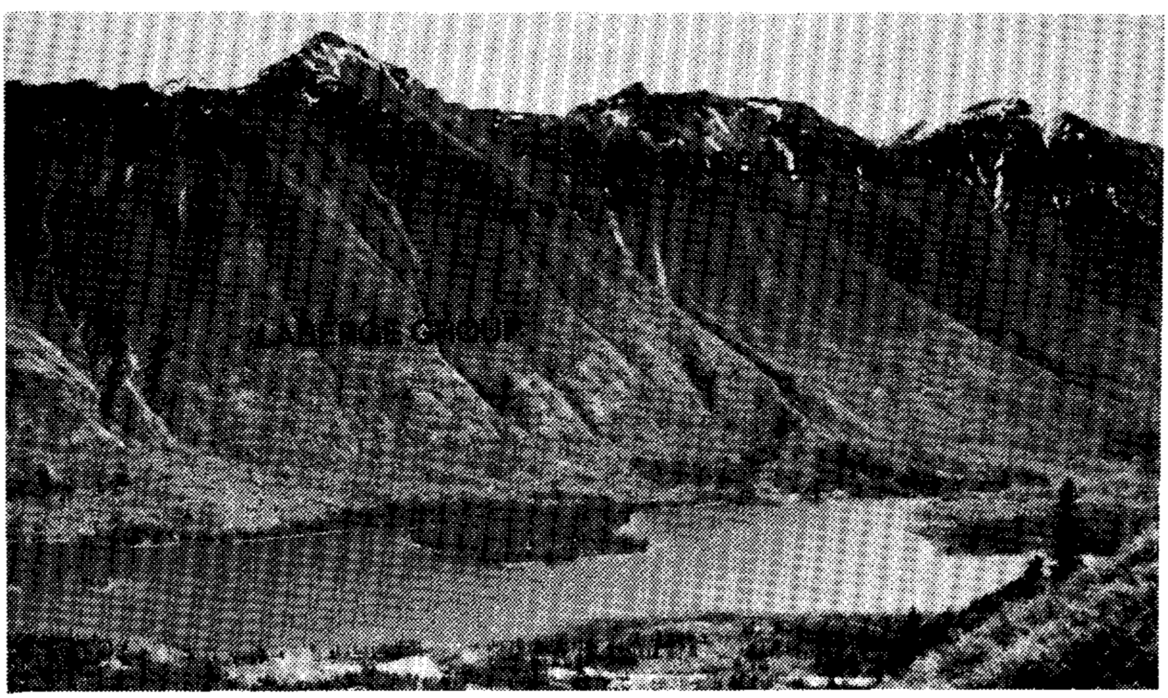

Figure 11. Resistant Late(?) Cretaceous volcanic rocks unconformably overlying folded Laberge Group strata on Grey Ridge, east of Annie Lake.

Volcanic rocks of the K_V unit comprise basic to intermediate lava flows with intercalated agglomerate, epiclastic rocks and minor silicic flows and pyroclastic tuff. Resistant, massive bedded, dark green and maroon andesite flows are the most predominant rock type, and dacite flows occur intermittently throughout the section. The flows are both aphanitic and porphyritic, containing fine-grained plagioclase (10-15%), hornblende (0-5%) and rare quartz phenocrysts. Associated with the flows are massive to thick bedded, heterolithic breccias composed of 45-65% lithic fragments in a green, aphanitic groundmass. The clasts range in size from 1-30 cm, and are composed of angular to subrounded volcanic and sedimentary rocks of varying compositions. Volcanic fragments are the most abundant and commonly have oxidized reaction rims The breccias are thought to represent mainly debris flows and agglomerates. Massive, black, aphanitic basalt flows comprise the southernmost part of the volcanic assemblage, forming the ridges adjacent to the Carcross Pluton.

Isolated occurrences of aphanitic to weakly porphyritic siliceous flows and lithic tuffs occur throughout the volcanic complex, irregularly interbedded with the intermediate flows. The flows are grey to light green coloured, commonly flow banded, and form irregular shaped pods or lenticular beds (10-50 m) which interfinger with the intermediate flows.

Age and Interpretation

These volcanic rocks are older than Early and Middle Jurassic sediments which they unconformably overlie but younger than the Paleocene Carcross Pluton. They are significantly different than Cretaceous volcanic rocks described on either Montana Mountain or Mount Stevens (K_{V1}). They are assumed to be latest Cretaceous in age and part of the Carmacks Group.

This volcanic assemblage is of limited lateral and vertical extent, and facies interpretations for the assemblage is therefore difficult to attempt. The absence of sedimentary rocks suggests that the volcanic rocks accumulated in a subaerial environment. Volcanic rocks of similar age (K_V) on the adjacent map sheet to the west (Doherty and Hart 1988) are not closely comparable and relationships remain uncertain.

CRETACEOUS RHYOLITE (K_r)

Outcrops of sub-volcanic rhyolite are infrequently scattered throughout the map sheet generally as individual dykes less than 2 m thick. Most of these occur in the mountains around Windy Arm. A small elongate plug is found in the Bennett Range near the B.C. border, and another slightly larger body cuts Whitehorse Trough strata on the east side of Mt. Gilliam (105D/7). Rhyolite dykes on the western slopes of Grey Ridge, although previously thought to be Eocene are considered by the authors to be Cretaceous in age.

There appear to be two generations of Cretaceous rhyolite. The first forms pale to rusty orange, brittle, well fractured, typically fine-grained dykes, but larger bodies commonly contain orange-pink feldspar (sanadine?) phenocrysts up to 8 mm. They differ only slightly from Eocene rhyolite described by Doherty and Hart (1988) in that they are more siliceous and lack characteristic flaggy partings. This rhyolite may be associated with late stage volcanism of the Montana Mountain Complex (94 Ma) or on Grey Ridge (Late Cretaceous?).

A second generation of rhyolite forms pale orange-white, saccharoidal textured, quartz-rich rhyolite to aplite dykes that are too small to be mapped,. These are exposed on Mt. Stevens and the northern Montana Mountain Complex. They resemble dykes in the southern border phase of the Carcross pluton.

The Bennett Range rhyolite plug contains characteristics of Cretaceous rhyolite and Eocene ring dyke rocks (Lambert 1974; Doherty and Hart 1988). The exposure is equidistant between the Eocene Bennett Lake Complex and the Montana Mountain Complex and its origin is indeterminate.

NOMENCLATURE

Nomenclature of Cretaceous volcanic rocks in the southern Yukon has been in a state of evolution for the greater part of this decade. While the unit names have essentially remained constant (Mt. Nansen, Carmacks and Hutshi Groups) the ages and therefore the application of the unit names have changed. This section discusses the terminology used in this report.

Mt. Nansen Group volcanic rocks were originally considered to be equivalent to Hutshi Group. They were thought to be latest Cretaceous to Eocene in age (Tempelman-Kluit and Wanless 1975; Le Couteur and Tempelman-Kluit 1976; Tempelman-Kluit 1980). Roots (1981) suggested the rocks of the Montana Mountain complex belong to this Group. Work by Grond et al. (1984) documented Mt. Nansen Group rocks as being Late Cretaceous in age.

Carmacks Group rocks have previously been considered Eocene to Pliocene in age (Tempelman-Kluit 1974, 1976, 1978, 1980b; Noel 1979), or Late Cretaceous and nearly contemporaneous with the Mt. Nansen Group (Tempelman-Kluit 1980a, Grond et al. 1984). Additional dating by Lowey et al. (1985) confirmed the Late Cretaceous assignment.

Hutshi Group were considered by Wheeler (1961) and Bultman (1979) to be broadly mid-Cretaceous in age. An Rb/Sr date from a sample taken near Atlin however returned a Late Cretaceous age (Grond et al. 1984).

Tempelman-Kluit (1984) has assigned a variety of middle Cretaceous volcanic rocks to the Mt. Nansen Group and a variety of upper Cretaceous volcanics rocks to the Carmacks Group. This nomenclature has been maintained by Wheeler and McFeely (1988) and is used in this report.

The term Hutshi Group is redundant and no longer needed.

COAST PLUTONIC COMPLEX

Recent mapping in the project area has defined approximately 20 different plutonic units in the Coast Plutonic Complex (Doherty and Hart 1988, Hart and Pelletier 1989). They range in age from Late Triassic (or older?) to Eocene and their morphological and mineralogical characteristics vary according to their age.

Triassic intrusions form large concordant batholiths of medium- to coarse-grained, megacrystic potassium feldspar granite to granodiorite which may be weakly foliated. Middle Cretaceous intrusions are elongate, northwest trending plutons commonly longer than 10 km and composed of medium grained hornblende granodiorite to diorite. Late Cretaceous to Paleocene intrusions are large and may be either circular or elliptical in plan. They are characterized by a predominance of biotite over hornblende as the primary mafic mineral and coarsely crystalline granite to quartz monzonite with megacrystic perthitic pink feldspar. Eocene intrusions form small (diameter<5 km), high-level discordant, alaskite or leucogranite stocks with characteristic smokey quartz-eyes and very few mafic minerals.

Ultramafic rocks are associated with upper Paleozoic rocks of the Atlin Terrain and upper Triassic Lewes River Group.

BENNETT RANGE GRANITE (Tr_{gr})

Resistant, dark-grey, lichen covered blocky outcrops of the Bennett Range granite underlie most of the Bennett Range and exposures on either side of Bennett Lake. The granite intrudes rocks of the Lewes River Group and is cut by the Llewellyn and other faults of the Tally Ho Shear Zone.

Large, euhedral, tabular, pink potassium feldspar megacrysts up to 5 cm in length characterize the unit. They vary from pale pink to fleshy brown and contain plagioclase and hornblende poikilicrysts. Potassium feldspar occupies 30% of the rock but crowded cumulates may contain 70% megacrysts. Equal portions of subhedral plagioclase and quartz comprise the interstices. Hornblende laths comprise 10 to 25% of the rock, and accessory minerals include biotite and sphene.

Many outcrops are strongly fractured and show crude alignment of broken mineral grains. Megacrysts are often aligned due to settling and give the impression of a foliation.

This unit is lithologically similar to the Pennington granite (LK_{gr}), but can be differentiated on the basis of slightly darker, creamier, less perthitic megacrysts, and interstitial quartz. The younger intrusion has no crude alignment or foliation and has smokey grey subhedral quartz. Many small plugs of the Pennington granite intrude Bennett Range granite on the Bennett Range making mapping of lithological contacts difficult.

Outcrops of megacrystic potassium feldspar granite east of the Llewellyn Fault are problematic. They are similar in appearance to the Bennett Range Granite but this unit has never before been observed east of the Llewellyn Fault and the proximity of Pennington granite calls to question the affinity (and age) of these exposures.

Age

A discordant, upper intercept age of 220$\pm$5 Ma has been determined by radiometric U-Pb zircon dating undertaken in the Fenwick Creek map area (105D/3) to the west (Doherty and Hart 1988). Relationships seen in the map area are consistent with the Late Triassic age for the granite.

PYROXENE MONZONITE (M_{MZ})

Diorite and monzodiorite of uncerain age underlies Pyramid Mountain on southern Grey Ridge. It forms an isolated, high standing intrusion bounded by both intrusive and faulted contacts within the Paleocene Carcorss Pluton. Its original size and configuration are unknown due to its limited exposure. The intrusion encloses a linear wedge of Triassic volcanic rocks which appear to have a concordant contact at both the top and base, suggesting the unit may be sill-like.

Resistant, dark grey weathering, medium to coarse-grained diorite composed of plagioclase (65-75%) and pyroxene (25-30%) forms the major part of the intrusion. On the knob west of Pyramid Mountain, light grey weathering monzodiorite also includes 10-15% potassic feldspar phenocrysts (1.5-2 cm). Plagioclase is partially to completely sericitized and mafic minerals are completely replaced by chlorite. Partial silicification of the rock is also seen in thin section, with microcrystalline quartz overprinting all mineral phases.

The origin and age of the intrusion is indeterminate. No comparible intrusive units occur in the project area. On the basis of its composition and field assosiation it is possibly related to Triassic mafic volcanism.

WHEATON VALLEY GRANODIORITE (JK_{gd})

The Wheaton Valley granodiorite is exposed in the western portion of the map-area on Mt. Stevens, near Midnight Gulch and near Millhaven Creek. Exposures comprise narrow (>1km) fault blocks juxtaposed against the Tally Ho Shear Zone. This unit has previously been described by Doherty and Hart (1988).

The granodiorite forms blocky, resistant, light grey weathering outcrops of medium-grained, equigranular, hornblende granodiorite to quartz diorite. Exposures proximal to faults are moderately foliated and hornblende is often altered to chlorite.

This unit is cut by faults assumed to be Cretaceous in age and must be older than that event. Outside the map area, it intrudes Laberge Group and must therefore be younger than Middle Jurassic. Although this unit has not been dated radiometrically, on the basis of field relationships it is assumed to be late Jurassic to Early Cretaceous in age.

BIOTITE GRANODIORITE (K_{gd})

Dark grey, massive, medium- to coarse-grained hornblende-biotite granodiorite stocks intrude argillite of the Laberge Group on Caribou Mountain. The northern exposures contain fresh, black, subhedral porphyritic biotite which commonly exceeds 1 cm in diameter.

The stocks resemble, and are considered to be part of the mid-Cretaceous granodiorite suite. However, except for the prominence of biotite, it is not too dissimilar from the nearby Paleocene Carcross Pluton. It is rich in biotite possibly as a result of alumina enrichment through assimilation of the country rocks.

QUARTZ SYENITE (K_y)

Massive, black weathering, orange-brown to orange-pink, biotite quartz syenite is exposed near Stevens Creek, at the northwestern end of the Carcross Pluton. It is composed mainly of coarse-grained, grey to flesh coloured feldspar in a matrix of finer grained feldspar, black biotite and grey interstitial quartz.

The age of this unit is unknown and cross-cutting relationships were not observed. The quartz syenite unit does however resemble the proximal, and more siliceous Late Cretaceous Folle Mountain granite (Doherty and Hart 1988) and may represent a marginal phase.

PENNINGTON GRANITE (K_{gr})

A small elliptical stock on the east side of Bennett Lake at the Yukon-B.C. border consists of massive, dark grey weathering, coarse-grained to porphyritic biotite and hornblende biotite quartz monzonite and granite with perthitic potash feldspar megacrysts to 5 cm. Numerous small stocks of this unit intrude Triassic granite in the Bennett Range but are difficult to map due to the similarity of the two rock types and the irregular character of the intrusions.

In the Bennett Range, the pluton cuts Triassic intrusive and volcanics rocks. In British Columbia it intrudes rocks presumed to be middle and upper Jurassic (Mihalynuk et al. 1988). It also intrudes the trace of the Llewellyn Fault and therefore brackets the youngest movement along the fault.

Age and Interpretation

The age of the Pennington granite is unknown although it shows many of the characteristics of the Late Cretaceous to Paleocene suite of intrusions (this report, and Morrison 1979). It is the same lithology as the Jack Peak pluton (Mihalynuk and Rouse 1988) and similar to the Montana phase of the Carcross Pluton. Biotite K-Ar dating returned ages of 64.3$\pm$2.2 Ma on the Carcross Pluton (Morrison et al. 1979) and 89.5$\pm$2.6 Ma on the Jack Peak pluton (Bultman 1979).

FINGER MOUNTAIN GRANITE (T_{gr})

Massive, light orange to grey, slightly ressessive weathering, medium to coarse-grained, red biotite granite outcrops as a single stock on the east side of Finger Mountain.

This granite cuts megacrystic potassium feldspar granite presumed to be Triassic and porphyritic, hypabyssal andesite presumed to be middle or upper Jurassic.

CARCROSS PLUTON (P_C)

The Carcross Pluton extends 22 km from Montana Mountain to Grey Ridge. It crosscuts Mesozoic strata of the Whitehorse Trough, middle and Late(?) Cretaceous volcanic rocks, and the Nahlin Fault. It is typically steep sided and most contacts with the surrounding country rocks are sharp. The south end of the pluton is shallowly dipping as suggested by a broad zone of themal alteration. The pluton is texturally and compositionaly homogeneous with the exception of the Montana phase which extends approximately 3 km north from the southern margin.

Massive, grey weathering, fine- to medium-grained biotite-hornblende granodiorite to granite comprises the main part of the pluton. It is composed of plagioclase (35-40%), potassium feldspar (20-35%), quartz (20-30%) biotite (15-25%) and hornblende (5-10%). White potash feldspar is locally porphyritic, ranging in size from 1.5-2.5 cm. Propylitic alteration is common adjacent to late stage veins and dykes.

The Montana phase is distinguished from the main part of the pluton by its potassium enrichment. It is composed of light weathering, pink-mauve, medium-grained quartz monzonite and quartz-rich aplite along its southern border. The quartz monzonite is composed of potassium feldspar (40-45%), plagioclase (35-40%), pale grey quartz (10-15%) and minor mafic minerals (<10%) that are completely altered to chlorite. Roots (1981) designates the Montana phase as 'the mauve alteration type' on the basis of its distinct colour and pervasive alteration.

The border phase aplite comprises 10-15% quartz eyes (0.5 cm) in a fine-grained and granular, light orange groundmass. Aplite dykes occur locally in adjacent country rocks and sporatic toumaline stringers and breccias occur in the border phase.

Age and Interpretation

The pluton intrudes mid-Cretaceous (94 Ma) volcanic rocks of the Montana Mountain complex and volcanic rocks on Grey Ridge assumed to be Late Cretaceous (see K_V) and comagmatic with the pluton. The pluton has been dated at 64.3 ± 2.2 Ma using biotite K-Ar (Morrison et al. 1979). Morrison condiders this date uncertain and speculates possible Ar loss during Eocene plutonism. A zircon U-Pb age date currently in progress (R. L. Armstrong, University of British Columbia) will better define the age of the pluton.

STRUCTURAL GEOLOGY

The structure of the map area includes folds in both Whitehorse Trough and Atlin Terrane (Cache Creek) strata, as well as the Nahlin Fault, the Tally Ho Shear Zone, and structures particular to the Montana Mountain Complex which have been discussed previously.

WHITEHORSE TROUGH

Sedimentary strata of the Whitehorse Trough are deformed into north and northwest-trending folds. Those developed in massive rock units of the Lewes River Group are gentle to tight and upright with fold wavelengths of approximately 1-3 km. These are well developed between Needle Mountain and Spirit Lake. Folds in Laberge Group sediments are tight to isoclinal and upright to overturned, with fold wavelengths approximating 1 km. They are eastward verging, slightly northerly plunging and best developed in argillite on Caribou Mountain, near upper Wynton and Dundalk Creeks and beneath Cretaceous volcanic rocks on Grey Ridge. Folds formed on the slopes north of Crag Lake are similar, but trend northeast. This deviation is probably related to complexities associated with the Crag Lake Fault.

ATLIN TERRANE

The internal structure of the Atlin Terrane is complex and difficult to understand, due in part, to extreme variations in stratigraphy. However, most structures are comparable in style and trend to the Nahlin and Crag Lake Faults.

Exposures near the Nahlin Fault are strongly foliated and cut by numerous thrust faults similar to the Nahlin Fault. Strata are intensely folded into southwest-verging, tight to isoclinal, overturned to recumbent folds which are cut by southwest-verging thrust faults. Northwest-trending normal faults similar, but smaller in magnitude, to the Crag Lake Fault cut previously deformed rocks.

Monger (1969, 1975) has suggested two periods of deformation in portions of the Atlin Terrane.

FAULTS

Nahlin Fault

The Nahlin Fault is a terrane-bounding fault along which Cache Creek Group rocks of the Atlin Terrane are juxtaposed against Whitehorse Trough strata of the Intermontane Belt. The fault is best developed near Dease Lake in northern B.C., where lowermost Cache Creek Group strata and ultramafic rocks are brought up and deformed along a southwesterly verging thrust fault. This fault has not been previously recognized in the Yukon since its northern trace was mapped as being overlain (and intruded?) by younger Cretaceous volcanics.

In the map area, the western boundary of the Atlin Terrane abuts Jurassic Laberge Group, mid-Cretaceous Montana Mountain volcanic rocks and is cut by the Late Cretaceous Carcross Pluton. Cache Creek rocks near the contacts are variably sheared, foliated and brecciated and contain ultramafic bodies. Laberge Group rocks are deformed and distorted. The Atlin Terrane-Intermontane Belt contact near Pooly Creek is a north-northwesterly-trending, northeast dipping (65°) fault with a well developed zone of protomylonite and argillaceous gouge (Figure 12). Across Windy Arm the contact is less deformed but represented by several imbricated thrusts of Cache Creek and Montana Mountain volcanic rocks.

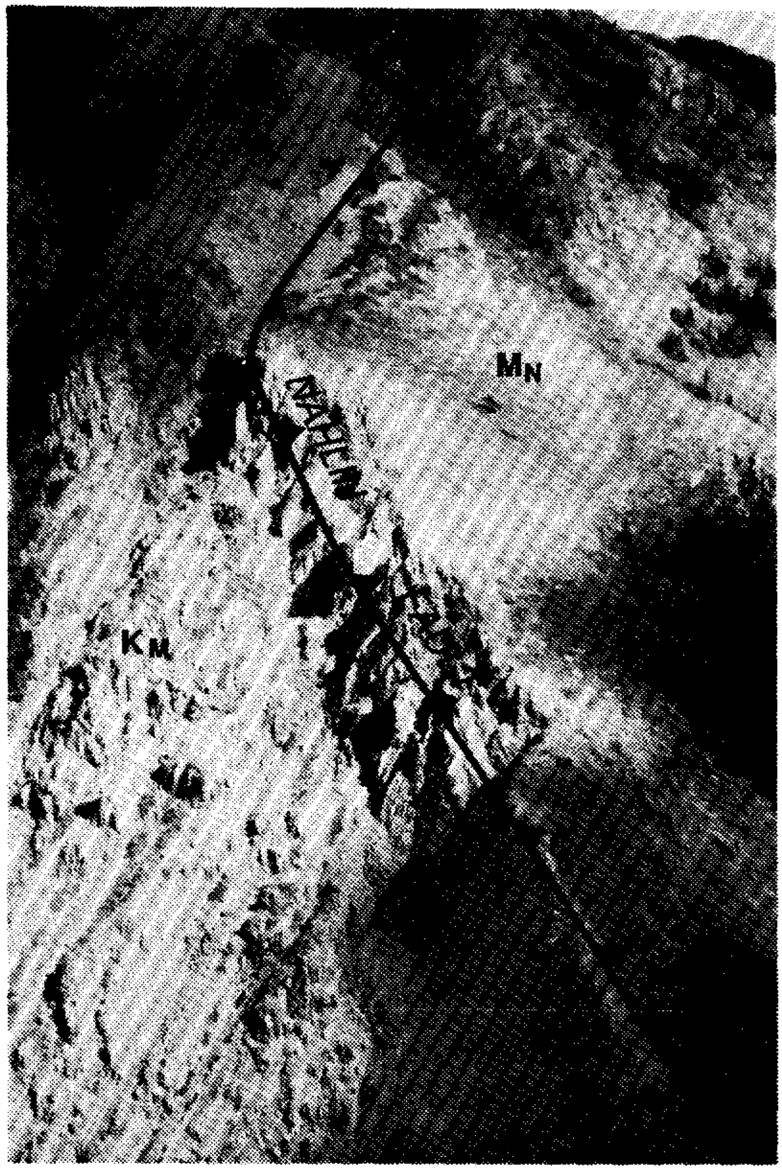

Figure 12. The Nahlin Fault as exposed near Pooly Canyon. This fault thrusts Cache Creek rocks (M_N) of the Atlin Terrane over mid- Cretaceous Montana Mountain volcanic rocks (K_M).

This structure is interpreted as the northern extension of the Nahlin Fault along which Atlin Terrane rocks were thrust(?) westerly over rocks of the Whitehorse Trough. The fault is intruded on the north by the 64 Ma Carcross Pluton and overlain to the south (in northern B.C.) by 72.4 Ma (Grond et al. 1984) volcanic rocks previously mapped as Hutshi Formation (now Carmacks Group) by Bultman (1979), but cuts rocks of the Montana Mountain complex as young as 88 Ma.

Near Dease Lake, movement along this fault has been well constrained to pre-Middle Jurassic time (H. Gabrielse 1988; pers. comm. 1989). Structural relationships in the study area suggest movement along the Nahlin Fault occurred during middle Late Cretaceous time between 72 and 88 Ma..

Crag Lake Fault

The northeast-trending Crag Lake Fault follows the Crag Lake valley and juxtaposes Nakina Formation rocks of the Atlin Terrane against the Laberge Group. Although it is nowhere exposed, the fault represents vertical movement at least equivalent to the thickness of the Laberge Group (2200 m) and probably the onlap (sedimentary) portion of the Lewes River Group as well as much of the Cache Creek Group (>7000 m).

The actual mechanism for movement along this structure is problematic and poorly understood. Most other bounding faults with the Atlin Terrane are west and southwest verging thrusts, making a north verging thrust fault unlikely. It is speculated that ramping and stacking of westward verging thrust faults in the Atlin Terrane caused vertical stress which resulted in a tear fault. That the south block moved west with respect to the north block is suggested by northeast plunging folds that are overturned to the southeast and the formation of northeast-trending phyllite (in argillite beds), north of the Crag Lake Fault (Wheeler 1961).

TALLY HO SHEAR ZONE

The Tally Ho Shear Zone (THSZ) is a northwest-trending, southwesterly dipping, 1-4 km wide zone of sheared and foliated Triassic volcanic and sedimentary rocks previously described by Doherty and Hart (1988). It forms the easternmost extent of Nisling Terrane metasediments and Triassic Bennett Range granite and the western margin of Whitehorse Trough rocks in southernmost Yukon. The THSZ is the northern extension of the Llewellyn Fault but is more complex than that mapped to the south (Mihalynuk et al. 1988).

Sheared and foliated Lewes River Group rocks of the THSZ extend along the western margin of the map area from the Bennett Range to Mount Stevens. Adjacent Triassic granite is foliated near its contacts with shear zone rocks. The shear zone geometry is relatively continuous, except on Dickson Hill and Mt. Stevens where it has been tectonically thickened and imbricated with Wheaton Valley Granodiorite. Millhaven conglomerate occurs in the imbricate zone as concordant, often strongly deformed, schistose, tuff-like beds.

The dramatic variation in thickness of Whitehorse Trough strata on either side of the THSZ is representative of the magnitude of vertical motion associated with the Llewellyn Fault. This movement may represent: 1) pre-Jurassic basin formation associated with the docking of Nisling Terrane; 2) listric basin development during Whitehorse Trough deposition; 3) post Middle Jurassic uplift and erosion of sediments deposited west of the THSZ; or 4) juxtaposition by strike-slip movement.

Brittle deformation of middle Cretaceous granodiorite in adjacent map areas (Doherty and Hart 1988) indicates that deformation has occurred at least since that time and probably represents a younger transcurrent episode. This motion may have been responsible for the imbrication of the Llewellyn Fault at Mt. Stevens.

ECONOMIC GEOLOGY

Mineral occurrences on the Carcross map sheet are dominated by the deposits on the Montana Mountain massif. Approximately 20 polymetallic Au-Ag fissure filling quartz veins occur along a 8 km long, northwest-trending belt - the largest of these, the Venus deposit, has been studied by Walton (1987). Other occurrences are typically copper-bearing precious metal veins hosted in the Tally Ho Shear Zone near Mt. Stevens and Millhaven Bay. All mineral occurrences are summarized in Appendix A.

MONTANA MOUNTAIN AREA

Vein deposits of the Montana Mountain area are hosted in rocks of the middle Cretaceous Montana Mountain volcanic complex and Late Cretaceous Carcross pluton (Figure 13). Veins are typically shallowly dipping to the northwest (Figure 14). Combined production from the area exceeds 150 000 tonnes, and current reserves are estimated at over 200 000 tonnes. Most occurrences show evidence of two mineralogically distinct stages which are best developed in the Venus vein and have been described by Walton (1986, 1987). The following information is adapted from Walton (1987) but new information regarding specific deposits is also included.

Vein material of Stage I comprises early quartz, arsenopyrite, pyrite while Stage II contains later quartz, sphalerite, galena and gold (Figure 15). Fluid inclusion data from the Venus deposit indicates that homogenization temperatures average 275° C with the Stage II fluids typically cooler. Isotopic evidence from seven local deposits indicates a meteoric-hydrothermal origin for the fluid and a high water:rock ratio.

Gold in Stage II fluids at Venus precipitated electrochemically in micro-fractures in Stage I sulphides, leaving Stage II quartz and sulphides depleted in gold. Such a process did not occur at the Uranus (and possibly other) veins where gold values are higher, and visible gold present in Stage II vein material. Venus and other veins (ie. Montana) show evidence of faulting concurrent with vein formation which may be responsible for increasing porosity in Stage I vein material and allowing gold precipitation at Stage I sites. Gold precipitation in veins lacking porosity in Stage I material, or lacking Stage I material altogether, may be the result of effervescence.

Venus (YEX No. 5)

Nearly 140,000 tons of proven and probable reserves grading 0.404 oz/ton Au and 7.67 oz/ton Ag have been calculated for the Venus deposit by Stubens (1988) who also suggests that the ore shoots occur as long, narrow vertically dipping zones.

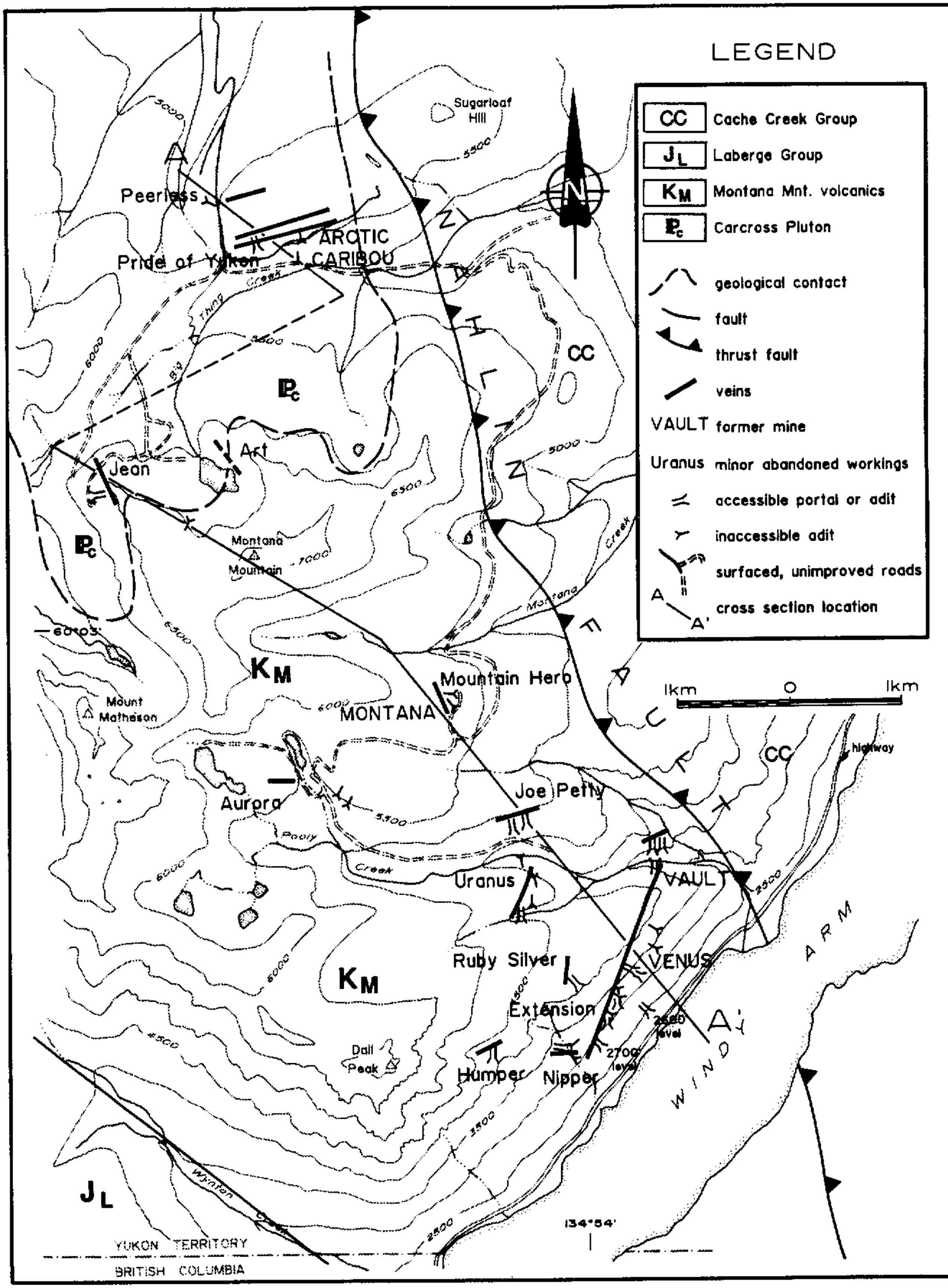

Figure 13. General geology and mineral occurrence locations of the Montana Mountain area. Locations and condition of portals and adits from Roots (1981).

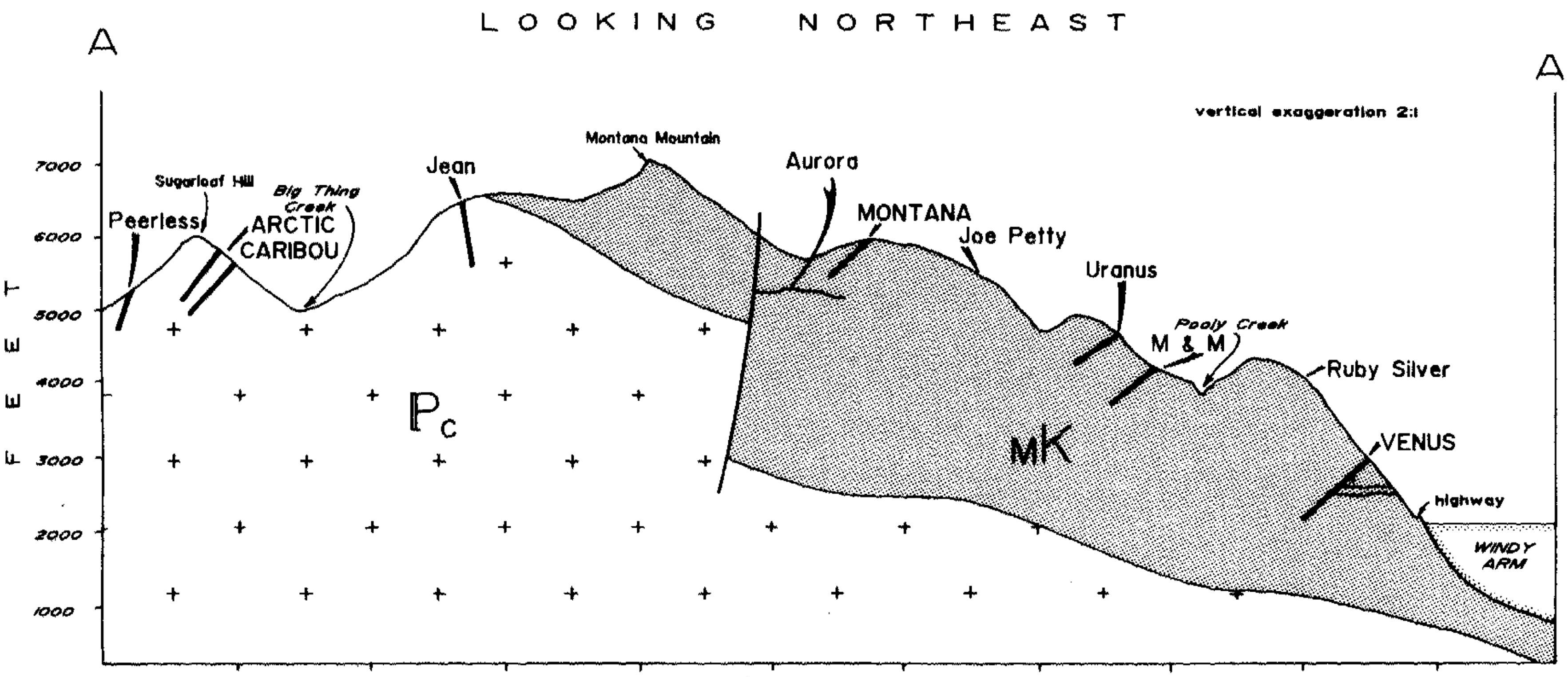

Figure 14. Generalized cross-section of Montana Mountain area showing general shallow dip of veins and shallow depth of intrusive beneath the southern portion of the complex.

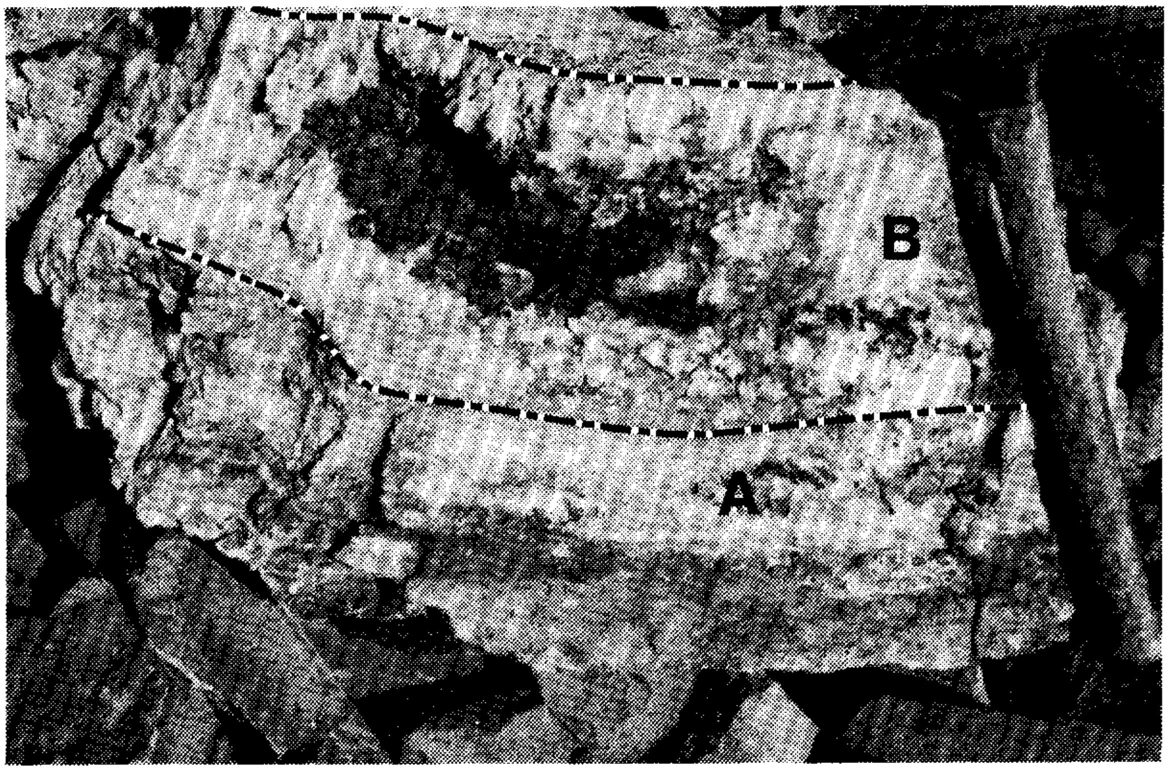

Figure 15. Two stage vein typical of most deposits of the Montana Mountain area. This vein, from the Uranus occurrence, shows; A - Stage I banded quartz, arsenopyrite, pyrite at vein margins, and B-Stage II vuggy cockscomb quartz and galena in the vein centre. Gold is associated with Stage II fluids. Average of two samples each: A-16.3 g/t Au, 50.5 g/t Ag and 0.38% Pb; B-46.5 g/t Au, 1903 g/t Ag and 13.3% Pb.

Morin (1981) determined ascending elemental increases in Au, Cu, As and Sb and decreasing Ag, Zn, Cd, Bi and Pb within 80 vertical meters of elevation in the Venus vein. The Au/Ag ratio also increases with elevation. Statistical analysis by Stubens (1988) has indicated that gold and silver grades are highest above the 2700 level and that the north portion of the vein is richer in gold than the south.

Jean (YEX No. 8)

The veins of this occurrence are not as well banded as others yet contain impressive precious metal values in veins with blebs of galena and no arsenopyrite. Although fluid inclusions of this occurrence have not been examined, the presence of tourmaline breccia at the top of the vein system as well as the similarity in mineralization to other occurrences in the Montana Mountain area, indicate a mesothermal origin.

Arctic Caribou/Peerless/Pride of Yukon (YEX No. 9,188,189)

These three sub parallel veins host remaining reserves of 74 757 tonnes grading 13.4 g/t Au and 349.7 g/t Ag (INAC 1988). The deposit is interesting since it is hosted in the Carcross Pluton. The mineralogy is similar to that of the other occurrences in the area however the alteration halos around the veins are extremely well developed. Argillic, phyllic and mild potassic and oxidized alteration assemblages give rise to porphyry style sequence of alteration. A halo of disseminated fine-grained pyrite occurs in patches surrounding the veins.

Joe Petty (YEX No. 136)

Veins at the Joe Petty occurrence contain do not contain Stage I type mineralization but host fine-grained quartz and sulphide minerals including tetrahedrite. Walton (pers. comm. 1988) has suggested that this deviation from typical Montana Mountain style mineralization may be due to its topographically higher position, and is therefore distal from the source. Homogenization temperatures are on average 75° C lower than those from the Venus deposit.

MOUNT STEVENS (YEX No. 31,32)

Vein occurrences on Mount Stevens are hosted in rocks of the Tally Ho Shear Zone. Many veins are intimately associated with quartz-rich aplitic dykes similar to those found near the margins of the Montana phase of the Carcross Pluton. Veins of coarsely crystalline white quartz are irregularly shaped and vary greatly in thickness and strike length. Sulphide minerals, mainly galena and pyrite, are sparsely distributed in the quartz and gold values are erratic.

The Mount Stevens veins differ from those on Montana Mountain in that they do not contain Stage I minerals and are richer in copper. Fluid inclusion data determined by Rucker (1987) indicates that mineralizing fluids are similar in isotopic composition and NaCl content to those on Montana Mountain. Mt. Stevens vein occurrences may have originated from the same source as those of the Montana Mountain area and are richer in copper due to high background copper values associated with the volcanic rocks in the Tally Ho Shear Zone.

The deposits of the Montana Mountain and Mt. Stevens areas fit the classification of a Cordilleran mesothermal deposit as defined by Nesbitt et al. (1986).

SUMMARY

Mineral occurrences in the Montana Mountain area had been thought of as being genetically related to the volcanic rocks or the, (previously considered to be coeval) Carcross Pluton. The genetic source of the ores must be younger than both the Early Paleocene pluton and the mid-Cretaceous volcanics which they cut.

Ore forming fluids are evolved meteoric in composition and therefore discount a magmatic origin. Such fluids are recognized as forming at depths of 9-12 km (Nesbitt 1989) and pressures of 1 $\pm$ 0.3 kbar (Nesbitt 1988). Such fluids require a vertically continuous, highly permeable zone or conduit, for rapid fluid upflow. Such zones are commonly attributed to deep seated, strike-slip (Nesbitt and Muehlenbachs 1988) or reverse faults (Sibson et al. 1988). The Nahlin Fault best represents such a structure.

Although the Nahlin Fault does not contain mineralized veins, zones of secondary fracturing are often the only areas mineralized (Sibson 1987). All Montana Mountain veins are within 3.5 km of the Nahlin Fault. An examination of the orientation of the mineralized structures in the Montana Mountain area indicates a preference perpendicular and oblique to the Nahlin Fault (Figure 16).

All veins are hosted in the brittle lithologies of the Montana Mountain volcanic rocks and Carcross Pluton. The barren Cache Creek Group greenstone may not have been able to maintain continuous vertical porosity under lithostatic loads at depths of many kilometers.

The ability of a permeable zone to distribute mineral-rich fluids several kilometers on either side of a structure is probably a function of the ability of the potential host rock to maintain permeability at depth. It has been suggested that the veins of the Montana Mountain area were emplaced at depths to 3 km (Walton 1987). The principle conduit for mineralizing fluids in the Montana Mtn. areas was highly fractured zones oblique-perpendicular to the Nahlin Fault.

NOTES TO PROSPECTORS

Further prospectings of the area would be best confined to slopes west of Brute Mountain where the hornfelsed Laberge Group sediments are fairly brittle and cut by several north-trending faults. Evidence of veining, once encountered on the ridges should be investigated at lower topographic levels. The weathering style of the sedimentary rocks is more likely to cover potential veins than the blocky weathering style of the Montana Mountain complex or Carcross pluton rocks. Areas of scorodite and manganese oxide staining may warrant investigation.

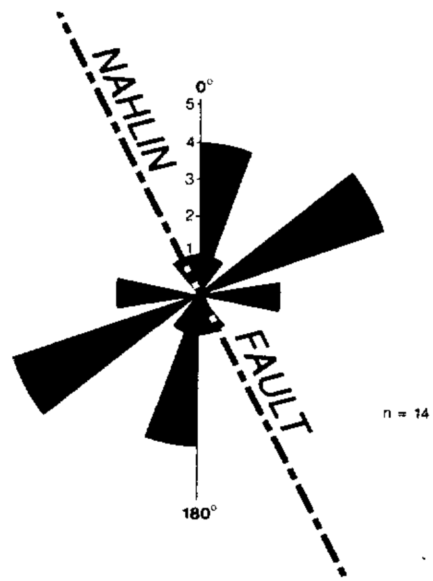

Figure 16. Rose diagram showing orientation of mineralized veins of the Montana Mountain area.

Rocks of the Cache Creek Group contain few mineral occurrences. Alteration is most pronounced adjacent to the Nahlin Fault. Mineral occurrences in Cache Creek Group rocks near Atlin are associated with hydrothermal alteration of ultramafic bodies east of the Nahlin Fault. Geological environments similar to those of the Atlin area exist in the Carcross map area and may deserve further attention.

Secondary dispersion halos are well developed but not areally extensive. Soil or talus fine surveys are accurate methods of determining the extent of unexposed mineralization (B. McKean consulting geologist, pers. comm. 1988).

Silt and heavy minerals analyses from drainages east of Mt. Gilliam are reported as being anomalous in base and precious metals (H. Copland pers. comm. 1987). Values of silver, copper, lead, zinc and less commonly gold, are anomalous in silt samples draining the Bennett Range (G.S.C. 1985).

No new mineral occurrences were found during the course of mapping, however three rock samples taken at sites other than known occurrences returned anomalous results and deserve further inspection.

A sample of white, rusty weathering, coarse grained quartz with minor pyrite taken from a 15 cm vein returned >10 000 ppb gold with 18.2 ppm Ag and anomalous As, Pb and Zn (Sample CH88 T15). A rerun of the gold value returned only 2300 ppb which possibly indicates the presence of coarse gold. The vein is part of a swarm of several which cut the Montana phase of the Carcross Pluton 1500 m north of the Peerless property.

Quartz breccia and chalcedony collected from a 0.5 m rusty weathering, northerly trending vein west of Brute Mountain, returned a gold value of 1400 ppb with slightly anomalous Ag, As and Cr (CH88-46-1). The vein is in one of a series of north-northwest trending strike slip faults. The chalcedonic matrix of the breccia suggests the vein, as exposed on the ridge at 5500' was sampled at a topographically high level and further prospectings should concentrate on tracing the vein at lower levels.

A sample of a galena-arsenopyrite-quartz float was located 0.5 km south of the Aurora adit (J48-1). Gold values of 1.59 opt (53 g/t) and silver 56.4 opt (1930 g/t) from the sample are much greater than those previously reported from the Aurora and Thistle veins. This sample may have been transported by man, but warrants further examination.

Crysotile fibres up to 20 cm long occur in fractures and joints in Horsefeed Formation (?) dolomitic limestone near Carcross.

REFERENCES

ANDERSON, R.G., 1989. The stratigraphic, plutonic and structural framework for the Iskut River map area, northwestern British Columbia; in Current Research Part E, Geological Survey of Canada, Paper 89-1E, p. 145-154.

BAIN, R.J., 1964. The Stratigraphy of the Permian Taku Group of the Tagish Lake area, Yukon Territory; Unpublished M.S. thesis, University of Wisconsin.

BLOODGOOD M.A., REES, C.J. and LEFEBURE, D.V., 1989. Geology and mineralization of the Atlin area, northwestern British Columbia; in Geological Fieldwork 1988, British Columbia Ministry of Energy, Mines and Petroleum Resources, Paper 1989-1, p. 311-321.

BOSTOCK, H.S., 1941. Mining industry of Yukon, 1939 and 1940; Geological Survey of Canada, Paper 44-34.

BOSTOCK, H.S., 1957. Yukon Territory, Selected Field Reports of the Geological Survey of Canada 1898 to 1933; Geological Survey of Canada, Memoir 284.

BULTMAN, T.R., 1979. Geology and Tectonic History of the Whitehorse Trough west of Atlin, British Columbia; Unpublished Ph.D. thesis, Yale University, 284 p.

CAIRNES, D.D., 1906. Explorations in a portion of the Yukon, south of Whitehorse; Geololgical Survey of Canada, Summary Report for 1906.

CAIRNES, D.D., 1908. Whitehorse and Tantalus regions; Geological Surveys Branch, Summary Report for 1907, p. 10-15.

CAIRNES, D.D., 1909. Preliminary Report on a portion of the Yukon Territory, west of Lewes River and between the Latitiudes of Whitehorse and Tantalus; Geological Survey of Canada, Summary Report for 1908.

CAIRNES, D.D., 1910. Wheaton River district, Yukon Territory; Geological Survey of Canada, Summary Report for 1909.

CAIRNES, D.D., 1916. Wheaton District, southern Yukon; Supplement to Geological Survey of Canada, Memoir 31, Summary Report for 1915.

CAIRNES, D.D., 1917. Lode mining in the Windy Arm portion, Conrad Mining District, Southern Yukon; Geological Survey of Canada, Summary Report for 1916.

COCKFIELD, W.E. and BELL, A.H., 1926. Whitehorse District, Yukon; Geololgical Survey of Canada Memoir 150, 63 p.

COCKFIELD, W.E. and BELL, A.H., 1944. Whitehorse District, Yukon; Geololgical Survey of Canada Paper 44-14.

COLE, F., 1989. Paleomagnetic and structural analyses of the northern Cache Creek Terrane near Atlin, British Columbia; in Cordilleran Tectonics Workshop, Program with Abstracts, University of British Columbia, 1989.

CRAIG, D.B. and LAPORT, P.J., 1972. North of 60 - Mineral Industry Report 1969 and 1970. Vol. 1 - Yukon Territory ans southwestern sector, Disrtict of Mackenzie; Canada, Indian and Northern Affairs Canada, Northern Economic Development Branch, Report EGS 1972-1, 199 p.

DAWSON, G.M., 1889. Report on Exploration in the Yukon District, N.W.T., and adjacent portions of B.C.; Geol. and Nat. Hist. Survey of Canada, Annual Report for 1887-1888, Vol. 3 (part 1); Report B, p. 5-261. See also Geological Survey of Canada, Pub. No. 626 in 1888.

DICKIE, J.R., 1988a. Laberge Conglomerates, Yukon: Evidence of a Late Triassic-Jurassic volcanic arc-continent collision; in GAC 1988, Program with Abstracts.

DICKIE, J.R., 1988b. Laberge Conglomerates, Yukon; Poster presentation at Yukon Geoscience Forum, November 1988, Whitehorse.

DOHERTY, R.L. and HART, C.J.R., 1988. Preliminary Geology of Fenwick Creek (105D/3) and Alligator Lake (105D/6) map areas; Indian and Northern Affairs Canada: Yukon Region. Open File 1988-2, two 1:50 000 maps and text, 65 p.

ERDMER, P., 1989. The Nisling schist in eastern Dezadeash map area, Yukon; in Current Research, Part E, Geological Survey of Canada, Paper 89-1E, p. 139-144.

FINDLAY, D.C., 1969a. The mineral industry of Yukon Territory and south-western District of Mackenzie, 1967; Geological Survey of Canada, Paper 68-68.

FINDLAY, D.C., 1969b. The mineral industry of Yukon Territory and south-western District of Mackenzie, 1968; Geological Survey of Canada, Paper 69-55.

FISHER, R.V. and SCHMINCKE, H.V., 1984. Pyroclastic Rocks; Springer-Verlag, Berlin, 472 p.

FYLES, J.G., 1950. Geology of the Northwest Quarter of Whitehorse Map-area,
Yukon, and Studies of Weathered Granitic Rocks near Whitehorse; Unpublished M.A.Sc. thesis, University of British Columbia.

GABRIELSE, H., 1988. Geological framework of northwestern British Columbia; in Geology and Metallogeny of northwestern British Columbia, Program with Abstracts, Smithers Exploration Group-G.A.C. Cordilleran Section Workshop, Smithers, B.C..

GEOLOGICAL SURVEY OF CANADA 1985. Regional Stream Sediment and Water Geochemical Reconnaissance Data, Whitehorse map sheet (105D) Yukon; Open File 1218.

GREEN, L.H., 1968. Lode mining potential of Yukon Territory; Geological Survey of Canada, Paper 67-36.

GROND, H.C., CHURCHILL, S.J., ARMSTRONG, R.L., HARAKAL, J.E. and NIXON, G.T., 1984. Late Cretaceous age of the Hutshi, Mount Nansen and Carmacks Groups, southwestern Yukon Territory and northwestern British Columbia; Canadian Journal of Earth Sciences, Vol. 21, p. 554-558.

HART, C.J.R. and PELLETIER, K.S., 1989. Geology of the Whitehorse (105D/11) map area; Indian and Northern Affairs Canada: Yukon Region. Open File 1989-2, 1:50,000 map and text.

INAC 1988. Yukon Exploration 1987; Exploration and Geological Services Division, Indian and Northern Affairs Canada: Yukon Region, 364 p.

JACKSON, J.L. and GEHRELS, G.E., 1989. Tectonic relations between the northern Stikine and Cache Creek Terranes, Yukon and British Columbia; in Results of preliminary investigations; Cordilleran Tectonics Workshop, Program with Abstracts, University of British Columbia, 1989.

LAMBERT, M.B., 1974. The Bennett Lake Cauldron Subsidence Complex, British Columbia and Yukon Territory; Geological Survey of Canada, Bulletin 227.

LOWEY, G.W., SINCLAIR, W.D. and HILLS, L.V., 1986. Additional K-Ar isotopic dates for the Carmacks Group (Upper Cretaceous), west-central Yukon; Canadian Journal of Earth Sciences, Vol. 23, p. 1857-1859.

LeCOUTEUR, P.C. and TEMPELMAN-KLUIT, D.J., 1976. Rb/Sr ages and a profile of initial $^{87}Sr/^{86}Sr$ ratios for plutonic rocks across the Yukon Crystalline Terrane; Canadian Journal of Earth Sciences, Vol. 13, p. 319-330.

MIHALYNUK, M.G. and ROUSE, J.N., 1988. Preliminary geology of the Tutshi Lake area, northwestern British Columbia (104M/15); in Geological Fieldwork 1987, British Columbia Ministry of Energy, Mines and Petroleum Resources, Paper 1988-1, p. 217-231.

MIHALYNUK, M.G., CURRIE, L.D. and ARKSEY, R.L., 1989. The geology of the Tagish Lake area (Fantail Lake and Warm Creek) (104M/9W and 10E); in Geological Fieldwork 1988, British Columbia Ministry of Energy, Mines and Petroleum Resources, Paper 1989-1, p. 293-310.

MONGER, J.W.H., 1969. Stratigraphy and structure of upper Paleozoic rocks, northeast Dease Lake map-area, British Columbia; Geological Survey of Canada, Paper 68-48.

MONGER, J.W.H., 1975. Upper Paleozoic rocks of the Atlin Terrane, northwestern B.C. and south-central Yukon; Geological Survey of Canada, Paper 74-47, 63 p.

MONGER, J.W.H., 1977. Upper Paleozoic rocks of the western Canadian Cordillera and their bearing on Cordilleran evolution; Canadian Journal of Earth Sciences, Vol. 14, p. 1832-1859.

MORIN, J.A., 1981. Element distribution in Yukon gold-silver deposits; in Yukon Geology and Exploration 1979-80, Geology Section, Dept. of Indian and Northern Affairs, Whitehorse, p. 68-84.

MORIN, J.A., MARCHAND, M., and DEBICKI, R.L., 1980. Mineral Industry Report 1978; Indian and Northern Affairs Canada: Yukon Region.

MORRISON, G.W., 1981. Setting and Origin of Skarn Deposits in the Whitehorse Copper Belt, Yukon; Unpublished Ph.D. thesis, University of Western Ontario, London, 306 p.

MORRISON, G.W., GODWIN, C.I. ARMSTRONG, R.L., 1979. Interpretation of isotopic ages and $^{87}Sr/^{86}Sr$ initial ratios for plutonic rocks in the Whitehorse map area, Yukon; Canadian Journal of Earth Sciences, Vol. 16, p. 1988-1997.

McCONNELL, R.G., 1906. Windy Arm district, Yukon; Geological Survey of Canada, Summary Report for 1905.

NESBITT, B.E. and MUEHLENBACHS, K., 1988. Genetic implications of the association of mesothermal gold deposits with major stike-slip fault systems; in Kisvarsanyi, G., and Grant, S.K., eds., Proceedings, North American Conference on Tectonic Control of Ore Deposits and the Vertical and Horizontal Extent of Ore Systems: Rolla, University of Missouri, p. 57-66.

NESBITT, B.E., 1988. Gold deposit continuum: A genetic model for lode Au mineralization in the continental crust; Geology, Vol. 16, p. 1044-1048.

NESBITT, B.E., MUROWCHICK, J.B. and MUEHLENBACHS, K., 1986. Dual origins of lode gold deposits in the Canadian Cordillera; Geology, Vol. 14, p. 506-509.

NOEL, G.A., 1979. Cenozoic rocks in western Canadian Cordillera of British Columbia and Yukon Territory; Geological Survey of Canada, Open File 659, 39 p.

NORTHERN CORDILLERA MINERAL INVENTORY, 1983. Private File, Archer, Cathro and Associates (1981), Ltd.

RALFS, K., 1975. A Study of the Mineralogy, Paragenesis, Zoning and Wallrock Alteration, Venus vein, Montana Mountain, S.W. Yukon; Unpublished B.Sc. thesis, University of British Columbia, Vancouver.

REID, R.P. and TEMPELMAN-KLUIT, D.J., 1987. Upper Triassic Tethyan-type reefs in the Yukon; Bulletin of Canadian Petroleum Geology, Vol. 35, No. 3, p. 316-332.

ROOTS, C.F., 1981. Geological setting of gold-silver veins on Montana Mountain; in Yukon Geology and Exploration 1979-80, Geology Section, Dept. of Indian and Northern Affairs, Whitehorse, p. 116-122.

ROOTS, C.F., 1982. Geology of the Montana Mountain area, Unpublished M.Sc thesis, Carleton University, Ottawa, 127 p.

RUEDISILI., L.C., 1965. The Stratigraphy and Paleontology of Permian Taku Group, Windy Arm, Tagish Lake, Yukon Territory; Unpublished M.S. thesis, University of Wisconsin.

SIBSON, R.H., 1987. Earthquake rupturing as a mineralizing agent in hydrothermal systems, Geology, Vol. 15, p. 701-704.

SIBSON, R.H., ROBERT, F. and POULSEN, K.H., 1988. High-angle reverse faults, fluid-pressure cycling and mesothermal gold-quartz deposits; Geology, Vol. 16, p. 551-555.

STUBENS, T.C., 1988. A Geostatistical Analysis of th Venus mine, Yukon territory; Unpublished M.A.Sc. thesis, University of British Columbia, Vancouver.

TEMPELMAN-KLUIT, D.J., (in press). Geology of Laberge and Carmacks map sheets; Geological Survey of Canada, Memoir.

TEMPELMAN-KLUIT, D.J., 1974. Reconnaissance geology of Aishihik Lake, Snag and part of Stewart River map-areas, west-central Yukon; Geological Survey of Canada, Paper 73-41.

TEMPELMAN-KLUIT, D.J., 1976. The Yukon Crystalline Terrane; enigma in the Canadian Cordillera; Geological Society of Americal Bulletin, Vol. 87, p. 1343-1357.

TEMPELMAN-KLUIT, D.J., 1978. Geological map of the Laberge map area (NTS 105E), Yukon Territory; Geological Survey of Canada, Open File 578.

TEMPELMAN-KLUIT, D.J., 1979. Transported Cataclasite, Ophiolite and Granodiorite in Yukon: Evidence of Arc-Continent Collision; Geological Survey of Canada, Paper 79-14, 27 p.

TEMPELMAN-KLUIT, D.J., 1980a. Evolution of physiography and drainage in southern Yukon; Canadian Journal of Earth Sciences, Vol. 17, p. 1189-1203.

TEMPELMAN-KLUIT, D.J., 1980b. Highlights of field work in Laberge and Carmacks map areas, Yukon Territory; in Current Research, Part A, Geological Survey of Canada, p. 357-362.

TEMPELMAN-KLUIT, D.J., 1981. Geology and mineral deposits of southern Yukon; in Yukon Geology and Exploration 1979-80, Dept. of Indian and Northern Affairs, Yukon, p. 7-32.

TEMPELMAN-KLUIT, D.J., 1985. Maps of Laberge (105E) and Carmacks(115I) map sheets, with legends. Geological Survey of Canada, Open File 1101.

TEMPELMAN-KLUIT, D.J. and WANLESS, R.K., 1975. Potassium-argon age determinations of metamorphic and plutonic rocks in the Yukon Crystalline Teranne; Canadian Journal of Earth Sciences, Vol. 12, p. 1895-1909.

WALTON, L.A., 1986. Textural Characteristics of the Venus Vein and implications for ore shoot distribution; in Yukon Geology Volume 1, Geological and Exploration Services division, Indian and Northern Affairs Canada, Yukon, p. 67-71.

WALTON, L.A., 1987. Geology and Geochemistry of the Venus Au-Ag-Pb-Zn Vein Deposit, Yukon Territory; Unpublished M.Sc. thesis, University of Alberta, Edmonton, 110 p.

WHEELER, J.O. and McFEELY, P., 1988. Tectonic Assemblage map of the Canadian Cordillera; Geological Survey of Canada, Open File 1565.

WHEELER, J.O., 1959. Mesozoic tectonics of southern-central Yukon; Geological Association of Canada, Proc., Vol. 11, p. 23-43.

WHEELER, J.O., 1961. Whitehorse map-area, Yukon Territory; Geological Survey of Canada, Memoir 312.

APPENDIX A

CHARACTERISTICS OF MINERAL OCCURRENCES

ABBREVIATIONS USED IN APPENDIX A

()	minor
//	parallel
ALTD	altered
ALTN	alteration
AND	andesite
BX	breccia
DDH	diamond drill hole
DISS	disseminated
GD	granodiorite
GP.	group
opt	ounces per ton
OXN	oxidation
POSS	possible
PPY	porphyry
PRODN	production
REPD	reported
RHY	rhyolite
TOT	total
U/G	underground

Ag	silver
Agt	argentite
Au	gold
Ca	calcite
Cc	chalcocite
Chl	chlorite
Cp	chalcopyrite
Cu	copper
Frb	freibergite
Gn	galena
Mag	magnetite
Mn	manganese
MnO	manganese oxide
Pb	lead
Po	pyrrhotite
Py	pyrite
Pyr	pyrangerite
Qtz	quartz
Sb	stibnite
Scor	scorodite
Slv	native silver
Sp	sphalerite
Stn	stephanite
Tet	tetrahedrite
Zn	zinc

YEX NUMBER	PROPERY NAME	HOST LITHOLOGY	ALTERATION	OCCURRENCE TYPE	MINERALOGY
2	LULU	ALTD NAKINA VOLCANICS	`SKARNEY' VEIN	VUGGY Qtz VEIN	Qtz,Mag,Py,Po,Aspy (Cp,Gn)
3	MILLET	ALTD NAKINA VOLCANICS		Cu IN BASIC LAVA	Native Copper
5a	VENUS	DK GREEN AND. & BX WITH FELSIC TUFF & DYKES	WIDE OXIDATION ENVELOPE, Qtz, SERICITE,Py,Chl CLAY GOUGE	WELL BANDED & COXCOMB Qtz VEIN WITH SLICKEN SIDES, WIDENING WITH DEPTH	Qtz,Aspy,Gn,Sp,Py (Cp,Pyr,Cc,Sb)
5b	VAULT	FELSIC PYROCLASTICS, RHY DYKES	5 m WIDE OXIDIZED ENVELOPE	N.END VENUS VEIN (TRACED 2km),SUGARY & CRYSTALLINE BANDED WHITE Qtz WITH SULPHIDES	Qtz,Aspy,Gn,Sp,Py (Cp,Pyr,Cc,Sb)
5c	EXTENSION	SILICIFIED & BX AND	Scor	Qtz VEIN, CONT. OF VENUS VEIN	Qtz,Aspy,Py,Gn (Sp,Pyr,Cp)
5d	NIPPER	GREY SILICIFIED AND. MOSTLY OXIDIZED	1-3 m ENVELOPE JAROSITE,CLAY,Py, Qtz,STRINGERS	GREY Qtz VEIN WITH STRINGERS, CONT. OF VENUS VEIN	Qtz,Aspy,Gn
6	MONTANA	MASSIVE DARK GREEN AND FLOW & BX, RHY PORPHYRY	SILICIFICATION, OXIDIZED ENVELOPE WITH CLAY AND MnO	WHITE Qtz VEIN WITH MINOR CHALCEDONY TRACED 100's m	Aspy,Gn,Py (Arg,Frb,Slv)
	MOUTAIN HERO ADIT	GREY AND PPY & BX	SILICIFICATION	NONE AT ADIT, MINOR Qtz ON HILL	Qtz,Aspy,Gn

YEX NUMBER	VEIN ATTITUDE	VEIN WIDTH	EXPLORATION DEVELOPMENT	PRODUCTION AND /OR RESERVES	REFERENCES
2	040-085/50 NW	12-45 cm	1907?:2 SHORT TUNNELS PRIOR 1941:30.5 m ADIT	REPOTED ASSAYS OF: 20.2 opt Ag, 4.6% Pb,0.63% Ni	INAC 1988, p. 101 INAC 1986, p. 74 FINDLAY 1969b, p. 39 CAIRNES 1908
3			HAND PITS		McCONNELL 1906
5a	010-050/35 W	0.2-4.0 m	EXTENSIVE U/G WORKINGS GREATER THAN 1500 m 2600,2650,2700 & 2800' LEVELS	PRODN: 73,635 TONS RESERVES: 140,000 TONS OF APPROX. 0.404 opt Au, 7.67 opt Ag, 3% Pb+Zn	WALTON 1987 ROOTS 1981 MORIN 1981 RALFS 1975
5b	170/35 N	7-50 cm, REPD (1906) 6-7 m UNDERGROUND	1906:90 m DRIFT		ROOTS 1981 WHEELER 1961, p. 129 CAIRNES 1908 CAIRNES 1906
5c	015/50 W	50-80 cm	1914: 100 m DRIFT 1922: SHAFT LATER PORTAL		CAIRNES 1916 CAIRNES 1906
5d	100/50 N	5-20 cm	1906:#1-10 m X-CUT, 12 m DRIFT #2-15 m X-CUT		ROOTS 1981 WHEELER 1961, p. 131 COCKFIELD & BELL 1929
6	135-170/37 SW	0.5-1.5 m	1905-1912:213 m ADIT, 94.5 m INCLINED SHAFT 1967:240 m DRIFT, TRENCHING	1905-1912:MINOR PRODUCTION	ROOTS 1981 MORIN 1981 FINDLAY 1969a, p, 60 WHEELER 1961, p. 128
			1905-1912:90 m X-CUT, PITS, TRAMWAY		ROOTS 1981 CAIRNES 1908

YEX NUMBER	PROPERY NAME	HOST LITHOLOGY	ALTERATION	OCCURRENCE TYPE	MINERALOGY
7	THISTLE (AURORA)	LT GREEN AND FLOWS & BX	THIN Qtz VEIN MINOR GREY Qtz	MINOR OXIDATION Scor	Qtz,Aspy,Gn (Pyr,Py,Slv)
8	JEAN	ALTERED MONTANA PHASE OF CARCROSS PLUTON	YELLOW CLAY, Py Chl, SERICITE	WHITE Qtz, MINOR BLUE GREY Qtz, RARE Ca WEAK BANDING	Qtz,Aspy,Gn, (Py,Sp,Sb)
9	ARCTIC CARIBOU (BIG THING)	ALTERED MONTANA PHASE OF CARCROSS PLUTON	10 m WIDE ALTER-ATION ENVELOPE OF WHITE CLAY, Chl,Py, HEMATITE, SERICITE	3 MAJOR Qtz VEINS CUT BY FLAT FAULTS, 2 MAIN VEINS DEVELOPED	Qtz,Aspy,Py,Gn,Ag (Cp,Au,Sb,Po)
10	CARCROSS	CARCROSS PLUTON GRANODIORITE		SEVERAL SMALL Qtz VEINS	Cu,Mo MINERALIZATION
11	KNOB HILL	LEWES RIVER GP BASALT (TrP)			
12	WABONA	CARCROSS PLUTON	Ept-Chl STRINGERS, SILICIFIED, GOSSANS	ALTD XENOLITH	Py (Zn)
13	COLLEGE GREEN	LEWES RIVER GP LIMESTONE & BASALT	WEAK CONTACT ALTN	Cu MINERALIZATION DISS ALONG CONTACT & IN SMALL VEINS & BLEBS	Py,Cp & OTHER Cu MINERALS

YEX NUMBER	VEIN ATTITUDE	VEIN WIDTH	EXPLORATION DEVELOPMENT	PRODUCTION AND /OR RESERVES	REFERENCES
7	070/80 N	2-5 cm (at lake	1907:18 m ADIT,		ROOTS 1981
		level)	TRENCHES		WHEELER 1961, p. 129
			1970: BULLDOZER		CAIRNES 1906
			CLEARING OF PORTAL		
			U/G? LARGE DUMP		
8	140/90-55 N	15-60 cm	1936,1950: TRENCHING	VALUES TO 8.6 opt Au,	INAC 1987, p. 153
			1961: 68 m X-CUT,	23.3 opt Ag	INAC 1986, p. 74
			TRENCHING; 1967,		ROOTS 1981
			1970,1987: DDH		GREEN & GODWIN 1964
			1988: TRENCHING		WHEELER 1961, p. 127
9	067/30 NW	0.15-0.61 m	1905-1916:2 ADITS	1910-15:3000 TONS	INAC 1988, p. 101
	040/40 NW	0.3.-0.46 m	1 INCLINED SHAFT WITH	(1.1 opt Au, 28 opt Ag)	INAC 1987, p. 208
			4 LEVELS, RAISES &	EXPORTED	ROOTS 1981
			STOPING >471 m	1967-69:PRODN OF 18,927	CRAIG & LAPORTE 1972
			1965:LOWER PORTAL	oz Au, 545,854 oz Ag	GREEN 1968
			1967:10,271 m DDH	FROM APPROX. 81,000 TONS.	WHEELER 1961, p. 126
			STOPE DEVELOPMENT	RESERVES-67,812 TONS	COCKFIELD & BELL 1926
				(0.39 opt Au, 102 opt Ag)	CAIRNES 1908, 1916
10			1967:2 DDH 305 m		INAC 1985, p. 157
					FINDLAY 1969, p. 62
11					WHEELER 1961, p. 121
12					DIAND 1985, p. 157
13			ROCK & SOIL		INAC 1987, p. 154
			SAMPLING		INAC 1985, p. 165
					WHEELER 1961, p. 142

YEX NUMBER	PROPERY NAME	HOST LITHOLOGY	ALTERATION	OCCURRENCE TYPE	MINERALOGY
14	FINGER	BASALT FLOWS & BX (Pvs)	CONTACT ALTN	Cu OCCURRENCE	Cp,Gn, MALACHITE
31	BUFFALO HUMP (GOLDEN SLIPPER, SUNRISE, WHEATON CLMS, MT.STEVENS)	GRANODIORITE (JKgd)		Qtz FISSURE VEIN EXPOSED 15.3m EXPOSED LENGTH	Qtz,DISS Gn,Py,Au, Slv
32a	ACME	CHLORITE & SERICITE SCHIST OF THSZ	WEAK SILICIFICATION	Qtz LENSES IN RHY DYKE	Qtz (Gn,Py)
32b	MIDNIGHT	SHEARED LEWES RIVER GP VOLCANICS (THSZ) CUT BY RHY DYKES	PROPYLLITIC ALTN OF RHY	Qtz VEINLETS IN RHY DYKES	Qtz,Py,Gn,Au
33	CROMWELL	SHEARED LEWES RIVER GP VOLCANICS IN THSZ		VEIN IN A SHEAR ZONE	Qtz,Gn
34	MILLHAVEN	SHEARED LEWES RIVER GP VOLCANICS IN THSZ		VEIN IN A SHEAR ZONE	Qtz,Gn,Cp, MALACHITE
66	RAILROAD	PROBABLY LEWES RIVER GP VOLCANICS (TrP)		VEIN CARRYING Ag	
97	ART (ROOTS)	PROBABLY MONTANA PHASE OF CARCROSS PLUTON		Au-Ag VEIN	Qtz,Aspy,Py (Gn)
104	BEN	PRE-TRIASSIC VOLCANICS CUT BY GRANITE	ARGILLIC & POTASSIC ALTN IN BX,	Au-Ag Qtz VEIN	Py,Gn

YEX NUMBER	VEIN ATTITUDE	VEIN WIDTH	EXPLORATION DEVELOPMENT	PRODUCTION AND /OR RESERVES	REFERENCES
14					DIAND 1985, p. 157 MIR 1978, p. 33-34
31	140/20-35 NE	MAX 2.5 m AVG 0.6-0.9 m	PRIOR TO 1908: GOLDEN SLIPPER: 25 m DRIFT, 6 m X-CUT		RUCKER 1987 INAC 1982, p. 117 WHEELER 1961 COCKFIELD & BELL 1926 CAIRNES 1910,1913,1916
32a		TO 9.1 m			RUCKER 1987 CAIRNES 1910
32b		DYKE:7.6-15.2 m VEIN:0.5 m	ADIT AT 1676 m 1986: 5 DDH 226 m 1987: 8 DDH 900 m	SURFACE:1.3 opt Au, 0.63 opt Ag. CORE: 0.34 opt Au 0.11 opt Ag OVER 0.46 m	INAC 1988. p. 107 INAC 1987, p. 165 INAC 1985, p. 160 WHEELER 1961, p. 121 COCKFIELD & BELL 1944
33				Ag VALUES	INAC 1985, p. 157 WHEELER 1961. p. 137
34	165/75 E		12 m ADIT	Cu,Ag VALUES	INAC 1985, p. 157 WHEELER 1961, p. 137
66					INAC 1985
97	NW?	0.20 m	1979:3 DDH		DIAND 1988, p. 112 NCMI
104	050-090/70 S	0.5-1.5 m	ROCK & SOIL SAMPLING		DIAND 1988, p. 116 MORIN ET AL. 1980, p. 33

YEX NUMBER	PROPERY NAME	HOST LITHOLOGY	ALTERATION	OCCURRENCE TYPE	MINERALOGY
136	JOE PETTY	GREY INTERMEDIATE FLOW WITH BRECCIA & VESICULAR HORIZONS	2 m OXIDIZED ENVELOPE	OXIDIZED WHITE & BLUE GREY Qtz IN SHEARED FISSURE	Gn,Ag MINERALS, MALACHITE, Tet
137	URANUS	INTERMEDIATE TO FELSIC PYROCLASIC FLOWS & ALTERED AND BX	OXIDATION	WHITE Qtz VEIN WITH VUGGY AND BANDED Qtz TRACED 500 m & 100's m VERTICALLY	Aspy,Gn,Prg,Ag,Py, Scor
138	M & M	PORPHYRY AND. FLOW, POSSIBLY BRECCIA BODY, WITH FELSIC DYKE RX	Scor.,MnO STRINGERS WITH Qtz	Qtz VEIN TRACED 50m	Qtz,Apy,Po (Stp,Frb)
188	PEERLESS (EXTENSION OF ARCTIC CARIBOU)	ALTERED GRANITE, ALTERATION ENVELOPE OF WHITE CLAY	ARGILLIC, Chl,Py, MnO	TWO STAGE Qtz-SULPHIDE VEIN	Qtz,Py,Aspy,Gn (Sp,Tet)
189	PRIDE OF YUKON (EXTENSION OF ARCTIC CARIBOU)	MONTANA PHASE OF CARCROSS PLUTON	ARGILLIC, Py,Chl SERICITE, OXIDIZED	TWO STAGE Qtz-SULPHIDE VEIN	Qtz,Aspy,Gn (Cp,Sb,Sp)
274	RUBY SILVER (RED DEER)	RHY PPY TUFF OR DYKE	OXIDIZED	VEIN IN VENUS HANGING WALL	Qtz,Gn,Pyr,Sp (Cp,Cc,Sb)
275	HUMPER	LT GREY SILICEOUS AND PORPHYRY & RHY DYKE	SCORIDITE IN DUMP, 2-4 m ENVELOPE OF MnO & GOETHITE	PINK & GREY Qtz VEIN WITH GOUGE (>500 m)	Qtz,Gn,Pyr (Stn)

YEX NUMBER	VEIN ATTITUDE	VEIN WIDTH	EXPLORATION DEVELOPMENT	PRODUCTION AND /OR RESERVES	REFERENCES
136	090/60 N	10-50 cm 1.8 m REPORTED IN 1906	1905:15 m SHAFT WITH DRIFTS, 12 m X-CUT WITH DRIFTS, 1968:TRENCHING 1988: PERCUSSION DH	1905:POSS PRODUCTION OF SEVERAL TONS	WALTON 1987 ROOTS 1981 WHEELER 1961, p. 128 CAIRNES 1908, 1906 McCONNELL 1906
137	010-160/40 SW	0.30-1.30 cm	1905:S.FORK ADIT 55m 1908:2 ADITS HAND TRENCHING 1985:DDH	1906:FEW TONS OF HAND SORTED ORE	WALTON 1987 ROOTS 1981 WHEELER 1961, p. 128 MCCONNELL 1906, p. 153
138	010/25-55 W	10-30 cm	1907-1914:TRENCHING & 3 ADITS TO 30 m	PRODUCED 5-6 TONS	ROOTS 1981 WHEELER 1961, p. 129 CAIRNES 1908, 1906 McCONNELL 1906
188	065/30 NW	15-61 cm	1905-1911:PITS & POSSIBLE ADIT 1936,1965:710 m ADIT TO PRIDE OF YUKON	1820 TONS OF ORE IN DUMP	ROOTS 1981 SEE NO. 9
189	?/NW SIMILAR TO No. 9	0.7-4.0 m	1905-1912:25 m OF U/G WORKINGS, INCLINE SHAFT	1912:2,525 TONS OF 1.03 opt Au 27.4 opt Ag	SEE No. 9
274	175/35 W RED DEER 030/N	15-40 cm	1907: 5 m ADIT 1929: RED DEER DUMP		ROOTS 1981 COCKFIELD & BELL 1926 CAIRNES 1916, 1908
275	060-095/35-65 N	30 cm	1910-1914(?): INCLINED SHAFTS TO 4 m & 21 m DRIFT	1906:300 opt Ag/0.23 m	ROOTS 1981 COCKFIELD & BELL 1926 CAIRNES 1916, 1908, 1906 McCONNELL 1906

APPENDIX B

ASSAY AND GEOCHEMICAL ANALYSES

ABBREVIATIONS FOR APPENDIX B

Ag	silver	frag	fragment
alt	altered	plag	plagioclase
an	andesite	lt.	light
app	approximately	po	pyrrhotite
As	arsenic	MnO	manganese oxide
assoc	associated	py	pyrite
aspy	arsenophyrite	occ.	occurs
bx	breccia	qtz	quartz
ept	epidote	ox	oxidation
diss	disseminated	rhy	rhyolite
Fe	iron	porph	porphry
dk	dark	sph	sphalerite
gn	galena	v.f.	very fine
f.g.	fine-grained	vis.	visible
Pb	lead	volc.	volcanic

Analyses performed by Bondar-Clegg & Company Ltd., Vancouver, B.C.

SAMPLE NO.	LOCATION	Au(ppb)	Au(opt)	Ag(ppm)	Ag(opt)	Cu	Mo	Pb	Sb	Zn	Bi	As	Te	W	Hg	Ba	Ni
CH88 T15	1.5 KM N. OF PEERLESS	>10000	(2300)	18.2		93	11	9472	16	1453	5	>2000	-	<10	55	650	1
CH88 40-1	MT. STEVENS DYKE	41		0.9		144	4	20	35	15	<2	23	-	<10	40	730	<1
CH88 45-3	BENNETT RANGE	14		0.6		142	<1	<5	13	76	<2	<5	-	<10	25	200	22
CH88 45-4	BENNETT RANGE	15		0.9		83	<1	19	7	29	<2	12	-	<10	15	220	8
CH88 44-4	FINGER MTN.	9		0.6		53	1	29	11	36	<2	18	-	<10	30	2400	9
CH88 46-1	LOWER BRUTE MTN., 5500'	1399		5.3		9	34	19	10	15	<2	225	-	<10	25	220	7
CH88 3-6	MT. CONRAD AREA	7		<0.5		4	<1	15	29	42	<2	53	-	<10	150	<20	10
CH88 48-2	RIDGE ABOVE JEAN		1.129	12.8		7	3	963	17	145	<2	>2000	-	<10	45	660	3
CH88 40-2	MT. STEVENS DYKE	15		0.9		6	<1	16	61	29	<2	53	-	<10	35	1300	5
CTH88 3	SOUTH OF DUNDALK MTN.	66		<0.5		62	<1	56	12	99	5	21	-	<10	25	2200	6
CH88 47-1	JEAN 6420'	53		1.1		203	<1	337	6	35	<2	237	-	<10	15	740	2
CH88 47-3	JEAN 6565'	47		0.7		5	5	380	22	20	<2	349	-	<10	40	570	5
CH88 47-4	JEAN 6565'	357		1.4		1	1	58	15	27	<2	>2000	-	<10	10	500	1
CH88 47-5	JEAN 6360'	368		6.9		24	<1	164	10	15	3	<2000	-	<10	10	930	3
CH88 47-6	JEAN 6360'		8.005		7.39	6	<1	2.82%	125	<10	2	>2000	-	<10	260	460	3
CH88 47-7	JEAN 5865'		1.794	38.3		11	2	1.4%	26	190	<2	>2000	-	<10	110	350	3
CH88 47-8	JEAN 5865'		0.818		3.41	54	2	3.04%	8	1.96%	16	>2000	-	<10	285	600=	3
CH88 K-A1	WABONA	21		0.6		35	2	34	9	96	<2	23	-	<10	40	980	33
CH88 KA-2	COLLEGE GREEN	363		9.3		11082	<1	21	8	26	11	53	-	<10	90	340	10

SAMPLE NO.	LOCATION	Au(ppb)	Au(opt)	Ag(ppm)	Ag(opt)	Cu	Mo	Pb	Sb	Zn	Bi	As	Te	W	Hg	Ba	Ni
MF 57-7B	NEAR BIG THING CK	9		1.2		50	6	77	9	47	<2	25	-	<10	10	710	24
CH88 56-10	JOE PETTY	146		18.1													
CH88 56-1	URANUS PIT #1	1621		34.46		1048	11	7.9%	596	1627	5	>2000	-	<10	330	20	4
CH88 56-6	URANUS ADIT		0.477		1.73	33	<1	3792	195	1198	<2	>2000	-	<10	105	<20	5
CH88 56-2	URANUS VEIN PIT #1		1.435		66.2	293	1	21.60%	1636	1104	10	>2000	-	<10	650	<20	<1
CH88 56-5	URANUS PIT		0.735		71.15	257	4	7.38%	1199	1.96%	<2	>2000	-	<10	1100	150=	<1
CH88 57-5	NEAR JEAN TAM	608		15.4		61	2	631	27	95	15	>2000	-	<10	15	240	5
CH88 12-2	1.5 KM S.W. MT. MATHESON	66		2.3		51	<1	421	7	84	<2	854	-	<10	15	390	2
CH88 10-1	MT. DEAN	<5		1.5		52	2	799	<5	256	7	42	-	<10	30	480	21
J48-1	NEAR AURORA		1.594		56.38	1684	<1	3933	1634	9231	<2	>2000	-	<10	2250	170	4
J48-2	2 KM S.E. MT. MATHESON	76		14.6		18	<1	346	27	136	3	159	-	<10	55	<20	7
J49-4	2 KM S. BRUTE MTN.	58		5.6		35	<1	64	<5	69	<2	96	-	<10	25	60	13
J44-1	GREY RIDGE	<5		<0.5		26	2	9	9	61	<2	35	-	<10	15	1700	4
CH88 53-1	ABOVE MILLHAVEN ADIT	7		1.8		22	45	121	120	50	17	100	-	<10	45	230	8
CH88 53-3	ABOVE MILLHAVEN ADIT	16		<0.5		149	25	102	15	66	3	95	-	<10	215	750	<1
MF59-3	PEERLESS		0.282	25.6		24	12	2622	343	13	20	>2000	-	<10	160	<20	1
MF59-4	PEERLESS	1144		3.9		10	2	111	79	3	<2	0.2	-	<10	20	<20	5
MF59-1	PEERLESS		0.415		6.11	737	<1	8096	517	1845	252	>2000	-	<10	115	<20	7
MF59-2	PEERLESS	454		10.4		97	30	607	48	40	14	705	-	<10	10	690	8

SAMPLE NO.	LOCATION	Au(ppb)	Au(opt)	Ag(ppm)	Ag(opt)	Cu	Mo	Pb	Sb	Zn	Bi	As	Te	W	Hg	Ba	Ni
J54-3	RIDGE ABOVE M+M	25		12.5		773	7	581	8	35	5	402	-	-	-	-	-
J54-1	URANUS VEIN	2670			17.54	153	<1	6909	448	909	4	>2000	-	-	-	-	-
J54-2	M+M VEIN	265			8.66	297	1	1829	79	255	<2	713	-	-	-	-	-
KP-A4	DAIL PEAK	<5		0.9													
KP-A5	DAIL PEAK	9		0.7													
KP-A6	DAIL PEAK	9		1.0													
KP-A7	DAIL PEAK	5		0.3													
CH88 26-6	AURORA	8700			50.07	1322	3	4281	967	3608	5	>2000	-	-	-	-	-
CH88 26-2		6		1.0		25	<1	130	10	95	12	28	-	<10	275	1400	10
CH88 26-4		<5		0.7		26	<1	209	10	58	7	16	-	<10	25	250	2
CH88 26-5		<5		<0.5		8	34	149	12	84	6	<5	-	<10	55	850	2
CH M1	MONTANA	2180			103.21	2737	<1	8078	1840	6920	9	>2000	-	-	-	-	-
CH M2	MONTANA	1580		39.0		786	1	2102	91	205	<2	>2000	-	-	-	-	-
CH M3	MONTANA	5660			40.45	531	11	10.60%	1207	3780	56	>2000	-	-	-	-	-
CH M4	MONTANA	1188			49.54	95	1	13.00%	696	1807	33	>2000	-	-	-	-	-
CH88 100-1	MT. STEVENS	44		3.4													
CH88 16-10	ARCTIC CARIBOU	2452		8.8		149	5	430	164	592	5	>2000	-	-	-	-	-
CH88 16-9	ARCTIC CARIBOU	5693			2.49	318	3	2539	140	97	95	>2000	-	-	-	-	-
CH88 14-3		<5		1.1		5	2	472	<5	85	3	43	-	<10	15	<20	2

Sample Descriptions

SAMPLE NO	DESCRIPTION	LAT	LONG
CH88 T15	White-rusty weathering, coarse-grained qtz. veined, <1% py	60 05' 56"N	134 42' 12"W
CH88 40-1	Lt. brownish weathering, rhyolite breccia with sub-parallel qtz veins, average 1-2mm thick. Up to 5% py (diss.) present	60 13' 18"N	134 59' 57"W
CH88 45-3	Brownish-yellow, bleached dacite dyke rock with 3% diss. sulphides (principally aspy, minor po and sph) Extensively limonitized	60 00' 34"N	134 57' 13"W
CH88 45-4	Reddish-brown, aphanitic andesite dyke with up to 5% po (app. 1% sph and aspy) as diss.	60 00' 10"N	134 56' 40"W
CH88 44-4	Brownish weathering, plag. porphyritic rhyo-dacite. 2% diss. Sulphides <1mm., mostly py. Mn-stained along fractures	60 03' 02"N	134 55' 31"W
CH88 46-1	White to orange-white weathering brecciated qtz vein With 5% vugs; 1 to 4mm. Banded chalcendony present, white to lt. grey on fresh surface. Wallrock frags are <1cm to 3cm long, strongly silicified. Minor limonit-ization is present. 160/55E chip over 0.5m.	60 04' 35"N	134 45' 56"W
CH88 3-6	Qtz-calcite vein 1-2cm with app. 60% massive to cockade white qtz. Calcite is more commonly limonite stained and is generally massive, occurring as thin (2-4mm) bands alternating with qtz.	60 00' 46"N	134 34' 19"W
CH88 48-2	Tan weathering, slightly vuggy (<5%) qtz vein, with up to 2% aspy as irregular blebs and diss. White on fresh surface; wall rock has been strongly sericitized. Up to 1% diss. Py present in wall rock.	60 03' 47"N	134 42' 45"W
CH88 40-2	Lt. greyish-brown altered rhyo-dacite with up to 6% diss. py. Up to 10% clay minerals are present. Limonitized on fracture surface.	60 12' 53"N	134 59' 43"W
CTH88-3	Calcite vein material from shear zone in conglomerates. Wall rock is extensively mylonitized and vein contains up to 5% anhedral qtz. Calcite is massive to fibrous and generally white on fresh surface. Azurite-malachite staining also present. Chlorite common along shear planes	60 00' 10"N	134 56' 40"W
CH88 47-1	Several sub-parallel qtz veins in alt. granite. Veins 4cm massive, white weathering qtz. Wall rock propylitically alt. sericitization occurs within 4cm of vein. Up to 5% vugs Tourmaline selvages. Float	60 03' 52"N	134 42' 58"W
CH88 47-3	Brownish-yellow stained granite with 5% vuggy qtz veins (1-5mm). Qtz contains <1% very fine diss. aspy. Wall rock extensively sericitized, Mn staining throughout. Vugs 10%, qtz veins fracture hackly	60 03' 52"N	134 42' 58"W
CH88 47-4	Lt. green to grey weathering, qtz vein contains 5% sulphides/ sulphosalts. Appr.2% diss. py.(euhedral py)	60 03' 52"N	134 42' 58"W
CH88 47-5	Lt. green weathering qtz vein with 10% sulphides, including 8% py. occurring as diss. and blebs 1cm. Gn occ. as diss. 102/80N. Chip 20 cm	60 03' 52"N	134 42' 58"W
CH88 47-6	Massive white to orange qtz vein with 10% sulphides. App. 5% sub- to euhedral gn occurring as blebs with aspy. 5% sph as irregular blebs near the vein boundaries. Wall rock strongly sericitized.	60 03' 52"N	134 42' 58"W
CH88 47-7	Lt. grey to orange weathering qtz vein with 20% sulphides as bands and irregular blebs. 10% is py, sub- to euhedral as bands 8mm . Gn in bands with py, also irregular blebs to 1cm. sph(3%) amd argentite(4%) in bands with py & gn.	60 03' 52"N	134 42' 58"W
CH88 47-8	White to yellowish-orange massive qtz vein, 5% sulphides Gn(4%) occ. as blebs 1cm. Argentite (1%), as blebs with gn Some py present	60 03' 52"N	134 42' 58"W

SAMPLE NO	DESCRIPTION	LAT	LONG
CH88 K-A1	Orange weathering, silicified rhyo-dacite with 1% diss. py occ. as v.f. sub- to euhedral grains	60 12' 33"N	134 53' 32"W
CH88 KA-2	Green-brown weathering altered basalt with azurite-malachite staining. 2% of rock is white qtz-ept veins, 1-3mm and are randomly oriented. 1% diss. py	60 09' 26"N	134 49' 43"W
MF 57-7B	Leached rhyolite bx. White, siliceous angular frags with limonite, some fine dull grey stringers of diss. sulphides Some dark grey/green angular frag. with dull grey sulphides	60 05' 04"N	134 33' 26"W
CH88 56-10	Rusty, massive white qtz in highly altered andesite with very f.g., dark grey, soft metallic minerals. Perhaps argt.	60 02' 11"N	134 38' 46"W
CH88 56-1	Rusty weathering, massive, white qtz, interlocking qtz crystals Gn occurs between qtz Xls. and bands at base of crystals Chip 40cm	60 01' 47"N	134 38' 58"W
CH88 56-6	Qtz vein, massive white banded qtz., bands are d. grey aspy Some scorodite staining from aspy bands, minor diss. gn 70% qtz, 30% mineralized bands	60 01' 47"N	134 38' 58"W
CH88 56-2	Rusty, massive and interlocking white qtz vein Massive gn and minor scorodite staining. 20% mineralization	60 01' 47"N	134 38' 58"W
CH88 56-5	Rusty, massive, white qtz vein. Vuggy white qtz with Xls Limonite staining. Massive gn in vugs, also bands and blebs in massive qtz plus scorodite staining. 80% qtz(20% vuggy) rest gn and limonite	60 01' 47"N	134 38' 58"W
CH88 57-5	Massive and interlocking white qtz vein with angular frags of Montana Mtn. granite, bx-weathers rust-orange. Fine bands of gn through qtz	60 03' 59"N	134 41' 40"W
CH88 12-2	Orange fractured siliceous sl. bx rhyolite dyke	60 02' 25"N	134 44' 32"W
CH88 10-1	Rusty weathering strongly altered qtz monzonite with 5% diss pyrite; resembles py shell of porph. system (4900')	60 00' 26"N	134 47' 36"W
J48-1	Rusty, white qtz vein float in massive andesite. Massive banded qtz with fine bands gn and vuggy qtz with qtz crystals. Some aspy on edge of open space qtz. Inside open space of qtz is dull grey, soft and tarnished mineral. Weathers to limonite.	60 02' 17"N	134 40' 58"W
J48-2	Qtz-calcite vein in andesite with white qtz growing from either side of vein, calcite is massive and surrounds qtz crystals. Crystals(.5 - 2cm). 90% sample qtz & calcite rest is chloritized andesite	60 02' 01"N	134 41' 17"W
J49-4	Vuggy white qtz vein bx in Laberge argillite, float, to 30 cm	60 04' 00"N	134 44' 42"W
J44-1	F.g., grey, silicified, frag. volc. carrying 15-20% diss. sulphides(po). Fe-stained rim of sample	60 15' 50"N	134 53' 00"W
CH88 53-1	White and pink bull qtz vein, some sulphides(py, po) in fractures	60 05' 55"N	134 58' 04"W
CH88 53-3	Weathering brilliant orange-yellow, similar to breccia, limonite. No vis. mineralization, all oxide.	60 05' 55"N	134 58' 04"W
MF 59-3	Coxcomb qtz crystals, massive sulphides aspy, gn and Ag. No Fe or As staining. Some epidote and chlorite.	60 05' 08"N	134 42' 02"W
MF 59-4	Massive qtz with 2-3mm veins. Sulphides are gn, aspy and dull silver mineral. Minor scorodite staining.	60 05' 08"N	134 42' 02"W
MF 59-1	Patches of massive aspy and gn. Sulphides with good crystals. Mineralization occ. in granite but sulphides in massive qtz Major Fe and scorodite staining	60 05' 08"N	134 42' 02"W
MF 59-2	Banded mineralization, massive and euhedral aspy plus massive d. grey/silver mineral. Mineralization not assoc. with qtz. Major Fe and scorodite staining. Gn also present	60 05' 08"N	134 42' 02"W
J 54-3	Near massive qtz crystals in veins. Bladed calcitecasts evident Bx in vein, no distinct mineralization	60 02' 13"N	134 37' 35"W

SAMPLE NO	DESCRIPTION	LAT	LONG
J 54-1	Qtz filled vein, crystals near massive. Ox mineralization minimal Aspy and gn present. Scorodite staining evident, also milky green mineral	60 01′ 47″N	134 38′ 58″W
J 54-2	Massive, rusty/brown qtz vein. Weathering localized to bands of dark, shiney mineral. Limonite and py crystals. Some areas of lt. grey, shiney metallic mineral; fine, thin coating	60 02′ 13″N	134 37′ 35″W
KP A4	Highly altered Montana Mtn. volc., very siliceous, possibly andesite. Rusty weathering surface along prominent fracture surfaces; limonite, possibly scorodite.	60 00′ 18″N	134 40′ 00″W
KP A5	Qtz vein in Montana Mtn. Massive andesite and dacite pile. Trending 031/84W. Space filling qtz crystals (1cm).	60 00′ 35″N	134 40′ 04″W
KP A6	Thin qtz stingers in silicified andesite. Rusty weathering. Rock altered beyond recognition but occurs in andesite pile	60 00′ 39″N	134 40′ 05″W
KP A7	Silicified intermediate volcanics with minor qtz stringers. Very rust weathering, probably limonite.	60 00′ 37″N	134 39′ 27″W
CH88 26-6	Banded qtz vein with gn and aspy with diss py.	60 03′ 01″N	134 39′ 29″W
CH88 26-2	White qtz in frost boil, no visible sulphides (6200′)	60 02′ 59″N	134 40′ 26″W
CH88 26-4	Rusty weathering qtz vein associated with rhy dyke (6200′)	60 02′ 59″N	134 40′ 50″W
CH88 26-5	Rusty weathering qtz vein associated with rhy dyke (6200′)	60 02′ 56″N	134 40′ 59″W
CH M1	Diss. blebs of gn and tetrahedrite in white cox qtz.	60 02′ 43″N	134 39′ 27″W
CH M2	Massive vitreous white qtz with dk. grey bands of gn f.g.	60 02′ 43″N	134 39′ 27″W
CH M3	Aspy, qtz, bx sinter with diss. aspy and bands of aspy. Gn and MnO?	60 02′ 43″N	134 39′ 27″W
CH M4	Massive, white, brittly fractured qtz with minor aspy and scorodite grading to cox. qtz with gn and excessive MnO oxdn on sulphides.	60 02′ 43″N	134 39′ 27″W
CH88 100-1	Massive, white bull qtz.	60 14′ 05″N	134 59′ 49″W
CH88 16-10	Banded qtz and aspy	60 05′ 05″N	134 40′ 58″W
CH88 16-9	Banded aspy, gn and qtz.	60 05′ 05″N	134 40′ 58″W
CH88 14-3	Massive white qtz as felsemeer, no vis. sulphides (6100′)	60 03′ 50″N	134 39′ 31″W

APPENDIX C

WHOLE ROCK GEOCHEMISTRY

ABBREVIATIONS FOR APPENDIX C

bio	biotite	alt.	altered
chl	chlorite	amyg	amygdule
fsp	feldspar	aph.	aphanitic
hb	hornblende	f.g.	fine grained
py	pyrite	lt.	light
pyx	pyroxene	mag.	magnetic
qtz	quartz	mtx.	matrix
		phenos	phenocrysts
		porph	porphyry
		sim.	similar
		sl.	slightly
		volc	volcanic

Analyses performed by Acme Analytical Laboratories Ltd., Vancouver, B.C.

	[illegible]	[illegible]	GR 1	CH46-2	P8846	CH13	T-4A	T-4B	CH4-2	CH4-7	CH5L	CH72	P8864	P8865	C6B-1	P8827	P8859	P8850	P8851	CH56-3
SIO2	[illegible]	[illegible]	55.30	50.62	60.27	41.89	.52.44	49.30	50.69	50.00	49.37	50.92	46.14	46.45	49.42	55.47	59.11	61.52	58.20	66.00
TIO2	[illegible]	0.25	1.02	0.62	0.72	0.01	0.42	1.21	1.34	1.12	1.42	0.33	0.82	1.03	0.93	1.02	0.83	0.64	0.83	0.42
AL203	[illegible]	15.34	17.76	11.28	15.93	1.75	11.01	14.95	14.42	14.25	16.32	14.05	12.82	13.40	14.17	14.86	14.86	16.38	15.34	13.67
FE203	[illegible]	2.01	7.63	8.61	6.25	10.06	7.07	11.25	12.01	12.09	9.20	6.31	9.00	10.95	8.40	6.71	5.30	8.08	7.83	3.31
FEO	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MNO	0.02	[illegible]	0.07	0.14	0.13	0.11	0.11	0.05	0.13	0.15	0.20	0.12	0.14	0.14	0.13	0.11	0.08	0.13	0.15	0.07
MGO	0.76	0.34	3.90	12.89	2.46	32.31	9.49	8.97	5.39	6.60	3.99	10.26	11.29	12.13	9.02	5.95	2.81	1.49	4.53	1.08
CAO	[illegible]	[illegible]	5.30	7.60	5.05	0.10	12.97	5.02	9.16	10.07	5.64	12.97	9.14	7.79	8.73	5.98	5.40	4.73	7.21	2.40
NA2O	4.08	[illegible]	3.33	2.14	4.14	0.09	1.08	2.31	2.89	2.51	4.07	2.25	2.84	1.65	1.96	4.12	3.56	3.50	2.64	3.45
K2O	1.08	[illegible]	0.87	1.66	1.75	0.05	0.19	0.65	0.57	0.78	3.40	0.09	0.42	0.44	2.04	1.17	1.91	1.21	0.84	3.70
H2O+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
H2O-	nd	nd	4.20	3.70	2.60	12.70	4.90	5.80	2.80	2.00	5.40	2.50	6.90	5.50	4.40	3.90	5.30	1.70	1.80	5.20
P2O5	0.05	[illegible]	0.32	0.36	0.26	0.01	0.04	0.16	0.11	0.08	0.17	0.03	0.17	0.20	0.35	0.39	0.29	0.24	0.27	0.15
TOTAL	100.00	100.00	99.70	99.62	99.56	99.08	99.72	99.67	99.51	99.65	99.18	99.83	99.68	99.68	99.55	99.68	99.45	99.62	99.64	99.45
Ba	324	[illegible]	635	576	1470											761	1475	1166	827	1260
Zr	nd	nd	157	59.00	105.00											140	150	107.00	101.00	150
CR2O3	.01000	[illegible]	.01000	.12000	.01000	.41000	.11000	.04000	.01000	.03000	.03000	.07000	.13000	.12000	.05000	.04000	.01000	.01000	.04000	.01000
BA	nd	nd	nd	nd	nd	24.00	48.00	103.00	818	180	2704	28.00	89.00	50.00	1266	nd	nd	nd	nd	nd
ZR	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	7.00	49.00	57.00	113	nd	nd	nd	nd	nd

	P8849	MM33-2	P8818	P88-57	P8832	P8832A	P8834	P8841	P8833	P8873	P8873A	P8868	CH15	CH66	CH66-8	CHT52	P8845	P8831	CH45-2	CH53-2
SIO2	71.08	72.47	63.73	65.24	51.42	52.16	49.11	52.66	51.39	53.28	53.16	51.05	70.47	67.24	72.56	74.20	66.80	65.63	69.31	72.95
TIO2	0.55	0.27	0.74	0.74	0.84	0.88	0.64	0.53	0.61	0.62	0.64	0.72	0.31	0.47	0.33	0.25	0.51	0.67	0.47	0.14
AL203	13.16	13.31	14.51	15.12	14.68	14.74	11.52	11.84	12.53	13.21	13.05	14.70	13.46	14.62	13.52	12.91	15.29	14.53	14.07	14.29
FE203	3.07	2.47	4.85	5.10	8.85	9.48	8.51	7.59	8.14	7.99	8.35	7.77	2.61	3.80	2.59	2.07	3.89	4.77	3.33	1.57
FEO	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MNO	0.06	0.05	0.07	0.08	0.15	0.15	0.15	0.13	0.14	0.13	0.14	0.12	0.05	0.06	0.04	0.04	0.08	0.08	0.09	0.04
MGO	0.47	0.54	1.44	2.09	8.69	6.79	14.26	10.96	11.72	8.71	9.58	3.33	0.75	1.48	0.63	0.47	1.46	2.26	0.94	0.47
CAO	2.17	1.31	3.46	2.76	9.83	8.30	8.67	7.60	8.89	8.15	7.64	9.45	1.57	2.55	1.05	1.15	2.60	3.61	2.15	1.85
NA2O	4.37	3.42	2.49	4.68	2.41	3.71	1.55	1.98	1.86	2.41	2.89	4.04	3.93	3.77	3.98	3.77	4.55	3.57	3.90	4.56
K2O	1.53	3.85	2.98	3.09	1.18	1.86	2.35	3.26	2.44	2.55	1.02	2.29	5.73	3.48	3.92	4.06	3.08	3.43	3.22	2.84
H2O+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
H2O-	3.20	1.80	4.90	nd	1.30	1.20	2.50	2.80	1.60	2.20	2.80	5.80	0.50	2.00	1.00	0.80	1.20	0.90	1.40	0.80
P2O5	0.17	0.09	0.26	0.28	0.32	0.39	0.33	0.30	0.29	0.37	0.38	0.35	0.08	0.15	0.11	0.07	0.18	0.22	0.17	0.05
TOTAL	99.83	99.58	99.43	100.00	99.67	99.66	99.59	99.65	99.61	99.62	99.65	99.62	99.46	99.62	99.73	99.79	99.64	99.67	99.65	99.56
Ba	450	986	1533	1773	486	326	661	1030	583	1059	811	1074	1076	1453	1036	746	1337	1064	1325	1555
Zr	198	155	169	161	87.00	59.00	37.00	44.00	49.00	53.00	53.00	55.00	nd	247	241	196	253	259	246	74.00
CR2O3	.01000	.01000	.01000	.01000	.06000	.01000	.14000	.09000	.10000	.07000	.08000	.01000	.01000	.01000	.01000	.01000	.01000	.01000	.01000	.01000
BA	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
ZR	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

	CH88-1	CH73	CH75-1	P88-75
SIO2	72.01	68.53	69.68	72.03
TIO2	0.15	0.48	0.50	0.34
AL2O3	14.86	14.34	14.15	15.36
FE2O3	1.51	3.79	3.06	2.08
FEO	nd	nd	nd	nd
MNO	0.03	0.07	0.13	0.03
MGO	0.39	0.99	0.88	0.92
CAO	2.02	2.59	1.91	1.93
NA2O	4.51	3.86	3.60	4.02
K2O	3.54	3.53	4.07	2.18
H2O+	nd	nd	nd	nd
H2O-	0.40	1.30	1.50	nd
P2O5	0.06	0.15	0.12	0.11
TOTAL	99.48	99.63	99.60	100.00
Ba	2062	1463	1539	nd
Zr	80.00	248	348	nd
CR2O3	.01000	.01000	.01000	.01000
BA	nd	nd	nd	1303
ZR	nd	nd	nd	128

Sample Descriptions

SAMPLE NO	UNIT	LOCATION	DESCRIPTION
CH 4-9	Kr	Upper Ramshorn Ck	Unaltered rhyolite, 40% subhedral plag, 6% green hb, 3% qtz-eyes in lt. green matrix.
CH 5-5	Kr	Escarpment Mtn.	Altered & slightly oxidized tawny orange, mottled rhyolite fsp porph; lots of oxides, no visible qtz.
GR 1	Kv	Grey Ridge	Auto brecciated andesite, plag. porphyritic, 15-25% plag phenos in f.g. maroon matrix, fragments (30-35%) of same
CH 46-2	Kv	West Brute Mtn.	Andesite, pyx porph(25-30%) but all mafic phenos alt to chl; oxidized red/maroon matrix.
P88-46	Kv	N. Grey Ridge	Andesite, plagioclase porphyritic (30-35%), red weathering
CH 13	CPub	Sugarloaf Hill	Very dark green, medium-grained, mag., serpentinized ultramafic.
CH T-4A	Mn	Upper Ramshorn Ck.	Similar to 4-2 with 20% mafics, unaltered, with selvages and 10% opaques. Light green, non-mag.
CH T-4B	Mn	Upper Ramshorn CK.	Dark grey with irregular calcite veining
CH 4-2	Mn	Escarpment Mtn.	Fine-grained, dk. green basalt, chl amyg, rare hb or pyx abundant opaques, sl. mag.
CH 4-7	Mn	Upper Ramshorn Ck.	Dark green basalt with lt. green altn bands; feldspar phenocrysts, pyx or hb to chl. 1% leucoxene, 8% opaques
CH5L	Mn	Escarpment Mtn.	Light green, altered andesite with chlorite amyg and relic plag to 6mm f.g. mtx with oxidized py
CH 72	Mn	Nares Mt.	Pale green, vitreous (recrystalized?) hb (40-45%) gabbro with plag. 50-60%.
P88-64	CPHvb	Bove Island	Aphanitic, light green basalt, 15-20% irregular shaped amygdules of black chl.
P88-65	CPHvb	Bove Island	Basalt (recrystallized), intergranular pyx and green plag(?)
CH68-1	CPHvb	Bove Island	Basalt, aphanitic (recrystallized?)
P88-27	Km1	N. Grey Ridge	Andesite, aphanitic, light green weathering with approx 10% black, altered mafics(?) and amygdules

SAMPLE NO	UNIT	LOCATION	DESCRIPTION
P88-50	Km1	Montana Mtn.	Andesite lapilli tuff, plag porph(25-30%) andesite with green aph. matrix, contains 10-15% frags of similar composition
P88-51	Km1	Montana Mtn.	Fine-grained andesite flow, 5-10% plag microlites in green-grey matrix
P88-59	Km1	Dail Peak	Andesite, 10-15% sericitized plagioclase phenocrysts in light green/ grey aphanitic matrix.
MM33-2	Km2	Mt. Conrad	Rhyolite, 5-10% K-spar phenos, <5% lithic frags in grey aph. matrix.
CH56-3	Km2	near Uranus	Rhyolite, brown weathering, pale green-orange sucrosic with occ. blue qtz-eyes and weathered out py.
P88-49	Km2	Montana Mtn.	Rhyolite, aphanitic (<5% phenos) green-pink, siliceous
P88-18	Km2	Base of Dail Peak	Rhyolite, 15-20% qtz. 20-25% plag, 5-10% bio(chloritized) in green aphanitic, vitric matrix.
P88-57	Kmvd	Dail Peak	Andesite porphyry, 15-20% plag(<1cm) in aphanitic maroon mtx
P88-32	TrP	Pyramid Mtn.	Black, aphanitic basalt, (recrystallized)
P88-32A	TrP	Mt. Grey	Basalt, pyroxene porphyritic (<10%)
P88-34	TrP	Mt. Grey	Basalt, pyroxene porhyritic (<10%)
P88-41	TrP	Bennett Lk.	Andesite, 15-20% pyx, <5% plag in maroon weathering matrix
P88-33	Trp	Mt. Grey	Andesite, 15-20% augite, <10% plag in dk. grey matrix
P88-73	TrP	Knob Hill	Andesite, 15-20% augite (sub-anhedral) in grey/green matrix, black on weathered surface.
P88-73A	TrP	Knob Hill	Same as P88-73
CH-53	TrPm	Millhaven Bay	Pyx porphyritic andesite (intrusive), weakly foliated, with 15-20% augite phenocrysts (to 2cm) in green-grey mtx which contains calcite vugs.
P88-68	uTA	Spirit Lake	Andesite-red weathering, mafics 5-10% completely altered to chlorite
CH 15	Pm	East Brute Mtn.	Medium to coarse-grained, pink weathering qtz-rich hb granite
CH 66	Pm	Sugarloaf Hill	Coarse-grained pink k-spar-rich biotite granite with 5-10% interstitial qtz, K-spar(45-55%), plag(25-30%), bio(5-10%), hb(<10%).
CH 66-8	Pm	Sugarloaf Hill	Mottled, dk. green, resistant f.g. basic volcanic.
CHT 52	mKy	N.of Mt. Stevens	Tan-pink to buff coarse-grained anorthositic plag syenite with 3% bio.
P88-45	JKgd	Mt. Stevens	Blotchy med-coarse grained, hb diorite; plag(60%-65%), qtz(10-15%), hb(15-20%), bio(<5%)
P88-31	Mmz	Pyramid Mtn.	Monzodiorite, medium grained, sausseratized
CH88-45-2	Trgr	Finger Mtn.	Strongly fractured megacrystic k-spar, qtz-rich granite.
CH 53-2	Trgr	Millhaven Bay	Weakly foliated, coarse-grained, megacrystic k-spar granite with 5% large hb and 15% strewn out qtz; K-spar phenocrysts up to 2.5cm, qtz to 1.5cm. Foliation defined by elongated qtz and plg.
CTH 88-1	Trgr	Finger Mtn.	Megacrystic-pink k-spar granite in fine-grained, pale green (sl. alt.) matrix of hb & plag and large white qtz-eyes (15%).
CH 73	lKgr	Bennett railcut	Pink coarse-grained megacrystic kspar, hb (minor bio.) granite. 6% mafics.
CH 75-1	Tgr	Finger Mtn.	Pink monzonite with green (altn) chl. from mafics, and pale green translucent plag. 10% clear qtz intersticial. Similar to Y88-6.
P88-75	Kr	Finger Mtn.	Rhyolite, 15-20% plag (resorbed?) in lt. green, siliceous matrix.