GEOLOGY OF THE TAGISH LAKE AREA (104M/8, 9E)

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KEYWORDS: Regional geology, Boundary Ranges metamorphic suite, Nisling assemblage, Stuhini Group, Laberge Group, Tagish volcanic suite, Coast Belt, Llewellyn fault, Engineer mine, gold veins.

INTRODUCTION

A third season of regional 1:25 000-scale geological mapping (compiled at 1:50 000) was completed in the Tagish Lake area between Skagway, Alaska and Atlin, British Columbia during 1989 (Figure 1-18-1). Tagish Project mapping began in 1987 at the division between the Coast and Intermontane belts on the British Columbia–Yukon border and has continued southeast on contiguous half map sheets, finishing this year near the south end of Atlin Lake, adjacent to the Atlin Provincial Park. Between early June and mid-September, approximately 1100 square kilometres were mapped in the Edgar Lake (104M/8) and Fantail Lake (104M/9E) areas to complement the 1700 square kilometres covered in the previous two seasons (Mihalynuk and Rouse, 1988a, b; Mihalynuk *et al.*, 1989a,b). A belt of metamorphic rocks in central 104M/8 was mapped by Lisel Currie (1990, this volume) as part of her doctoral thesis at Carleton University. Parts of this belt were also mapped as a component of this study.

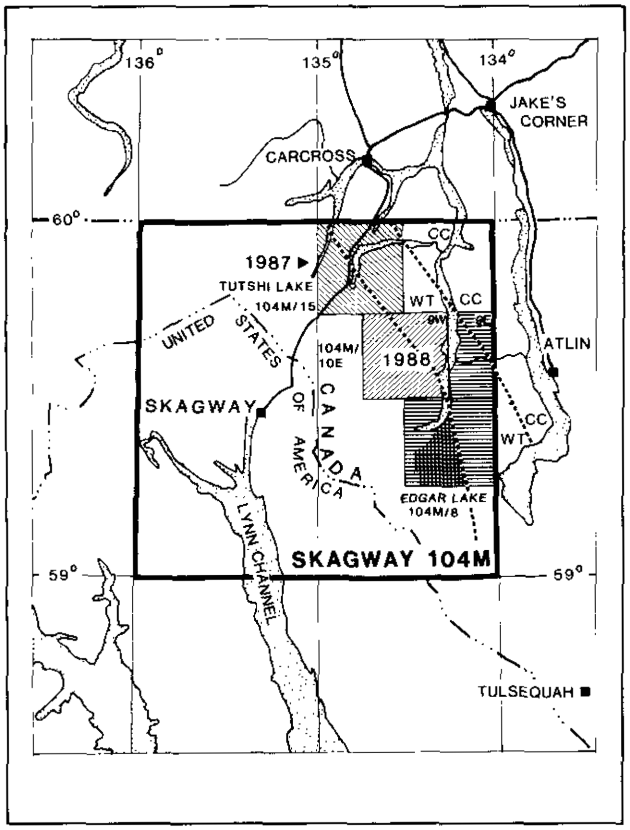


Figure 1-18-1. Location map showing the course of Tagish project mapping. The Whitehorse trough is outlined west of Atlin Lake by the dotted lines and is labelled WT; CC denotes Cache Creek Terrane. The double hatched region within 104M/8 outlines the study area of Currie (1990, this volume).

As in past seasons, a regional geochemical moss-mat survey was conducted in concert with geological mapping; sample density is approximately one per 12 square kilometres of drainage basin. Some ninety mineralized samples were collected for analysis to aid in evaluating the mineral potential of the area.

The area is part of an anomalous arsenic-antimony (and sporadic gold) province extending into the Yukon (Schroeter, 1986) and has high economic mineral potential. Mapping and sampling have been conducted to evaluate the involvement of depositional and late deformational processes in the formation of ore deposits. Potential hostrocks for mineralization range from Proterozoic(?)-Paleozoic metamorphics to Tertiary intrusives and extrusives.

ACCESS AND PHYSIOGRAPHY

Large lakes at elevations ranging from 656 to 844 metres provide boat access to about 30 per cent of the map area. These lakes are most easily reached by floatplane or helicopter, both stationed in Atlin some 40 kilometres to the east. During high water (early July through to late September) Tagish Lake can also be reached from Atlin by powerboat via the Atlin River. At highest water, this route is perilous and recommended only for experienced boaters.

Treeline varies from 1000 to 1400 metres elevation with major peaks extending to over 1900 metres. Rapidly receding glaciers cover about 20 per cent of the 104M/8 alpine area and both permanent and fresh snow covers many north-facing slopes for most of the summer months.

REGIONAL GEOLOGICAL SETTING

Extensive regional geological mapping was previously conducted in the area by Christie (1957) and Bultman (1979). Both have provided excellent guidance, and the generalized geological picture of this study does not vary greatly from that established by Bultman for strata within the Whitehorse trough (Figure 1-18-1).

NOTES ON THE TERRANE ARCHITECTURE

The map area covers a short segment of the north-northwest-trending boundary between the Coast and Intermontane geomorphological belts. The structural grain of the

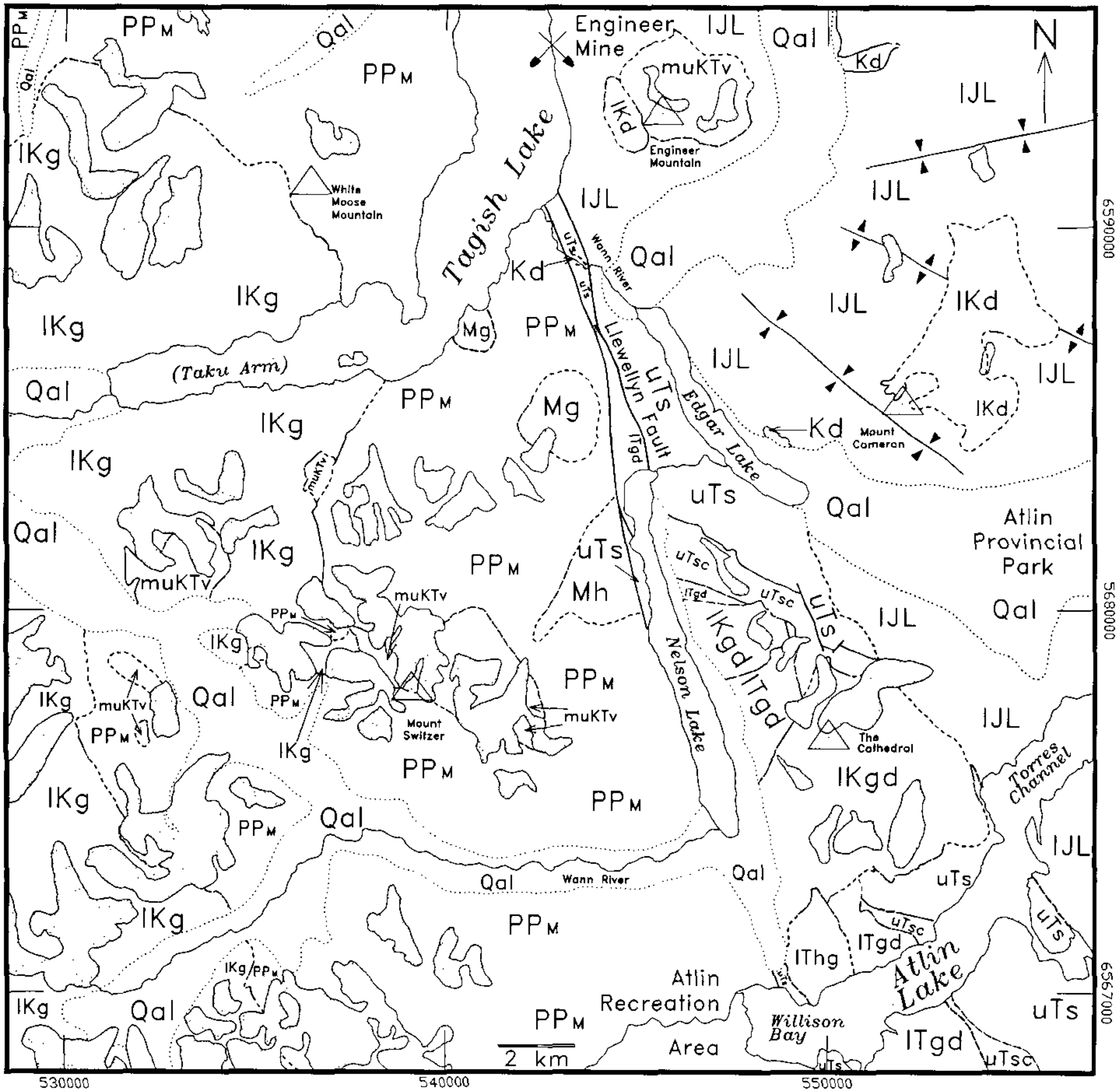
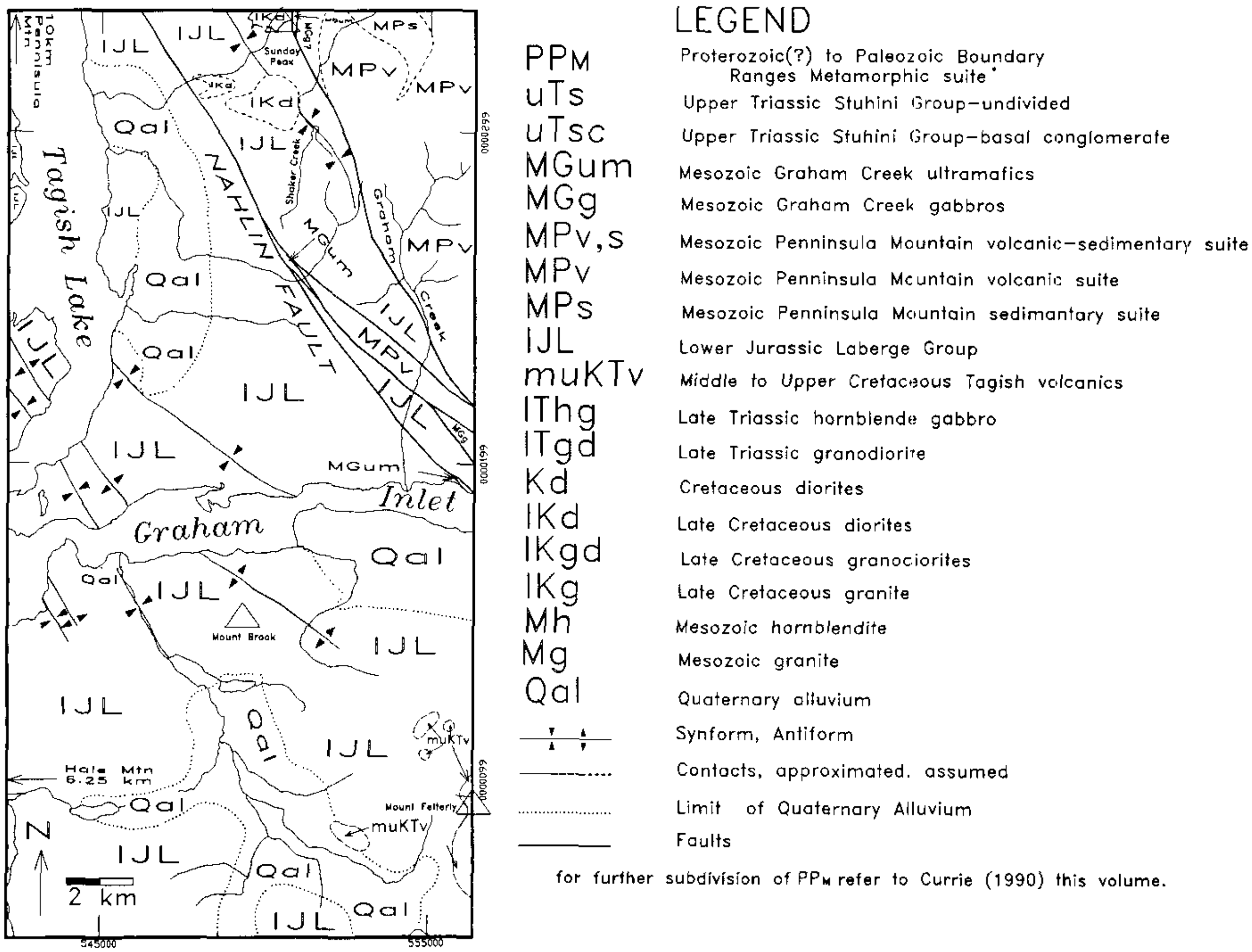


Figure 1-18-2. Simplified geology of 104M/8, *see* Currie (1990, this volume) for a subdivision of Unit PPM; the area mapped by Currie is shown by the double hatched pattern on Figure 1-18-1

entire area is subparallel to this boundary. This same boundary is roughly coincident with what has historically been considered the contact zone between undivided "central gneiss" (Tipper *et al.*, 1981), more recently termed the Nisling Terrane (Wheeler *et al.*, 1988) [This naming convention is followed by Mihalynuk *et al.* (1989), however, since the Nisling rocks have yet to be demonstrated as unique terrane, a name such as the "Nisling assemblage" is more suitable (D. Brew, personal communication, 1989)], and strata of the Whitehorse trough. In contact with the eastern margin of Whitehorse trough is the Cache Creek Terrane. Trough sediments are dominated by Upper Triassic and younger arc volcanics and clastics which are thought to overlap, and therefore link, the Proterozoic to Paleozoic metamorphosed and displaced Nisling continental margin assemblage to the west with low-grade oceanic rocks of the Cache Creek Terrane to the east. Thus, strata in the Whitehorse trough have come to be known as the Inklin overlap



assemblage (Wheeler *et al.*, 1988), yet in few places is an unconformable contact unequivocal. One such location is in the west-central Tutshi Lake area where probable Toarcian (late Lower Jurassic), belemnite-bearing conglomerates contain pebbles and boulders derived from the metamorphic rocks and rest with angular unconformity on the metamorphic suite. Even at this locality the contact has been masked by post-depositional shearing. In north-central Tutshi Lake area volcanic strata of presumed Late Triassic age also appear to rest unconformably on, as well as in fault contact with, the metamorphic suite. The eastern contact relationships are potentially more ambiguous because of lithologic similarities between rocks in the Whitehorse trough and the youngest sediments of the Cache Creek Terrane (J. Jackson, personal communication, 1989).

In south-central British Columbia, well-documented relationships show Cache Creek clasts in the Upper Triassic volcanic succession, and rocks with lithology identical to Upper Triassic volcanics within subduction-related mélange of the Cache Creek (Monger, 1984) demonstrating their proximity by Late Triassic time. Although no such clear cut relationship has been demonstrated in northwestern British Columbia, Bloodgood and Bellefontaine (1990, this volume) observe Norian and younger strata above Cache Creek rocks. They have not seen a stratigraphic contact, but one is expected. Their overling strata are gritty limestones of Norian age and a conglomerate containing clasts of this limestone, as well as boulders of intrusive rock and clasts derived from the underlying Cache Creek strata. Both lithologies are similar to rocks of the Stuhini Group in the Edgar Lake area (with the exception of Cache Creek Group clasts in the conglomerate). It therefore seems that conglomerates deposited on the eastern and western margins of the Whitehorse trough were derived respectively from the underlying Cache Creek Group and Nisling Terrane. This comprises an overlap assemblage consistent with the regional tectonic syntheses of Wheeler and McFeely (1987) and Wheeler *et al.* (1989).

LAYERED ROCKS

PROTEROZOIC(?) TO PALEOZOIC METAMORPHICS (PPm)

This belt of rocks, generally less than 15 kilometres wide extends from the British Columbia–Yukon border to south of Atlin Lake. Within the Florence Range (south-centra

104M/8) metamorphism attains upper amphibolite grade, but rapidly decreases eastward to transitional greenschist-amphibolite and greenschist adjacent to Nelson Lake. A similar, but more gradual, south to north decrease in metamorphic grade is also observed, with a low-grade culmination near the British Columbia–Yukon border. For a detailed description of these rocks within 104M/8 the reader is referred to Currie (1990, this volume). In brief, Currie recognizes four major lithologic subdivisions (roughly east to west; Figure 1-18-2): the Boundary Ranges metamorphic suite, Hale Mountain granodiorite, Wann River gneiss and Florence Range metamorphic suite. Boundary Ranges metamorphic rocks are predominantly chlorite-actinolite schists with lesser chlorite schist, thin marble, quartzite and orthogneiss (*see* also Mihalynuk *et al.*, 1989a, b). The foliated Hale Mountain granodiorite is medium grained, hornblende-biotite rich with plagioclase and less abundant but larger potassium feldspar augen. Epidote, evenly distributed as fine grains, is diagnostic. Wann River gneisses are well layered on a millimetre to decimetre scale, containing 20 to 60 per cent hornblende in layers alternating with quartzofeldspathic layers. Florence Range metamorphic rocks are pelites and semipelites (mostly without graphite), marbles, amphibolites, calcsilicates and minor quartzite. Currie has tentatively interpreted the contacts between these units as shear zones.

STUHINI GROUP (uTs)

Within southern 104M/8 a continuous section of Stuhini Group sediments and volcanic rocks displays units that can be correlated for tens of kilometres. The entire package represents a transition from coarse terrigenous sediments to submarine mafic volcanics. As the volcanic piles built, they became more felsic and less voluminous. After the end of volcanism, epiclastic and reefal carbonate deposition covered and preserved the volcanic piles. The culmination of carbonate deposition marks the top of Stuhini strata (Figure 1-18-3).

BASAL CONGLOMERATE (uTSc)

A basal conglomerate can be correlated intermittently from at least the south end of Atlin Lake to the British Columbia–Yukon border. Bultman (1979) termed these rocks Unit A of the Stuhini Group and recognized a similarity to the basal King Salmon Formation in the Tulsequah area (Souther, 1971). Where best developed it attains a thickness of at least 800 metres although its thickness is probably variable due to paleotopographic effects. Identifiable clasts range in size up to 2 metres, but are typically in the 2 to 20-centimetre range and invariably well rounded. The concentration of different clast types varies locally with intrusive, volcanic and metamorphic clasts prevalent.

No fossils have been identified in these rocks so their age is not precisely known, however, they sit unconformably atop potassium feldspar megacrystic hornblende granodiorites that elsewhere have yielded K-Ar (hornblende) and U-Pb isotopic dates of 212 to 220 Ma (BCGSB unpublished data; Bultman, 1979; Hart and Pelletier, 1989). Metamorphic clasts, in order of abundance, include muscovite-biotite schists (no aluminosilicates were observed) and phyllites, chlorite-muscovite schists, amphibolitic gneisses (Wann River gneiss) and rare marble.

Foliated intrusive clasts such as Hale Mountain hornblende granodiorite are locally abundant. Strongly foliated hornblende gabbro and diorite clasts derived from an older body are sparse but conspicuous. Potassium feldspar megacrystic hornblende granodiorite clasts are very evident due to their light colour (Plate 1-18-1a), but close to the parent body they may comprise almost 100 per cent of the outcrop, making it difficult to discern the sediment-intrusive contact. Foliated to unfoliated leucogranitic clasts are probably derived, to a large extent, from pegmatite and aplite dikes within Wann River gneiss and Hale Mountain hornblende granodiorite.

Volcanic clasts include pyroxene and feldspar-porphyritic varieties. Source terrains of two ages are probable as clasts derived from epidote-chlorite-actinolite-altered volcanic conglomerate indicate a previously eroded and hydrothermally metamorphosed volcaniclastic succession (*i.e.*, second generation conglomerates, Plate 1-18-1b). On the north

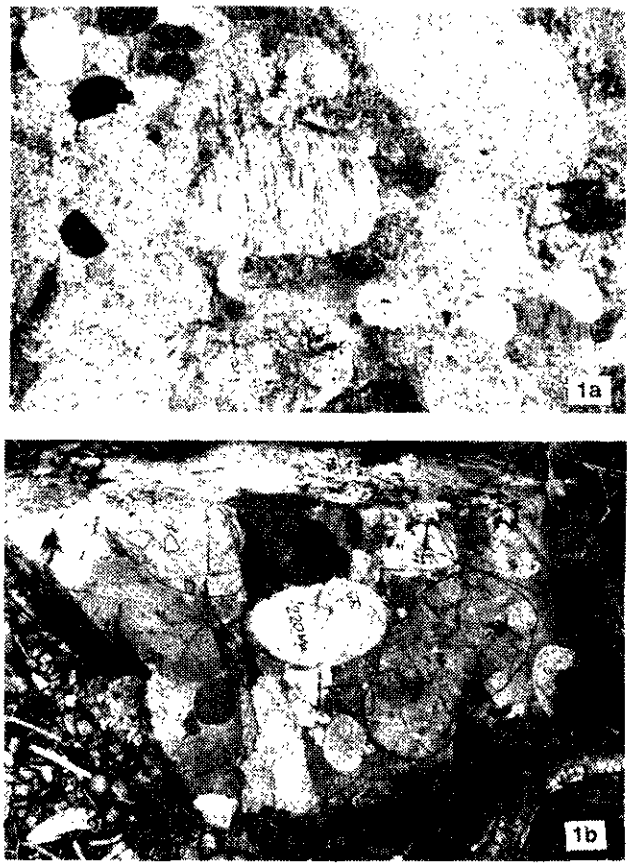


Plate 1-18-1. Upper Triassic basal Stuhini Group conglomerates: (a) clasts are composed of Hale Mountain intrusive, Wann River gneiss (well banded, centre), Late Triassic granodiorite, pegmatite and pyroxene-phyric volcanics in a medium to coarse-grained volcanic matrix. Large clast in centre is about 12 centimetres in maximum dimension; (b) a wave-washed boulder containing second generation cobble conglomerate (outlined) and epidote-altered lapilli tuffs (angular fragments outlined), as well as Late Triassic potassium feldspar megacrystic granodiorite.

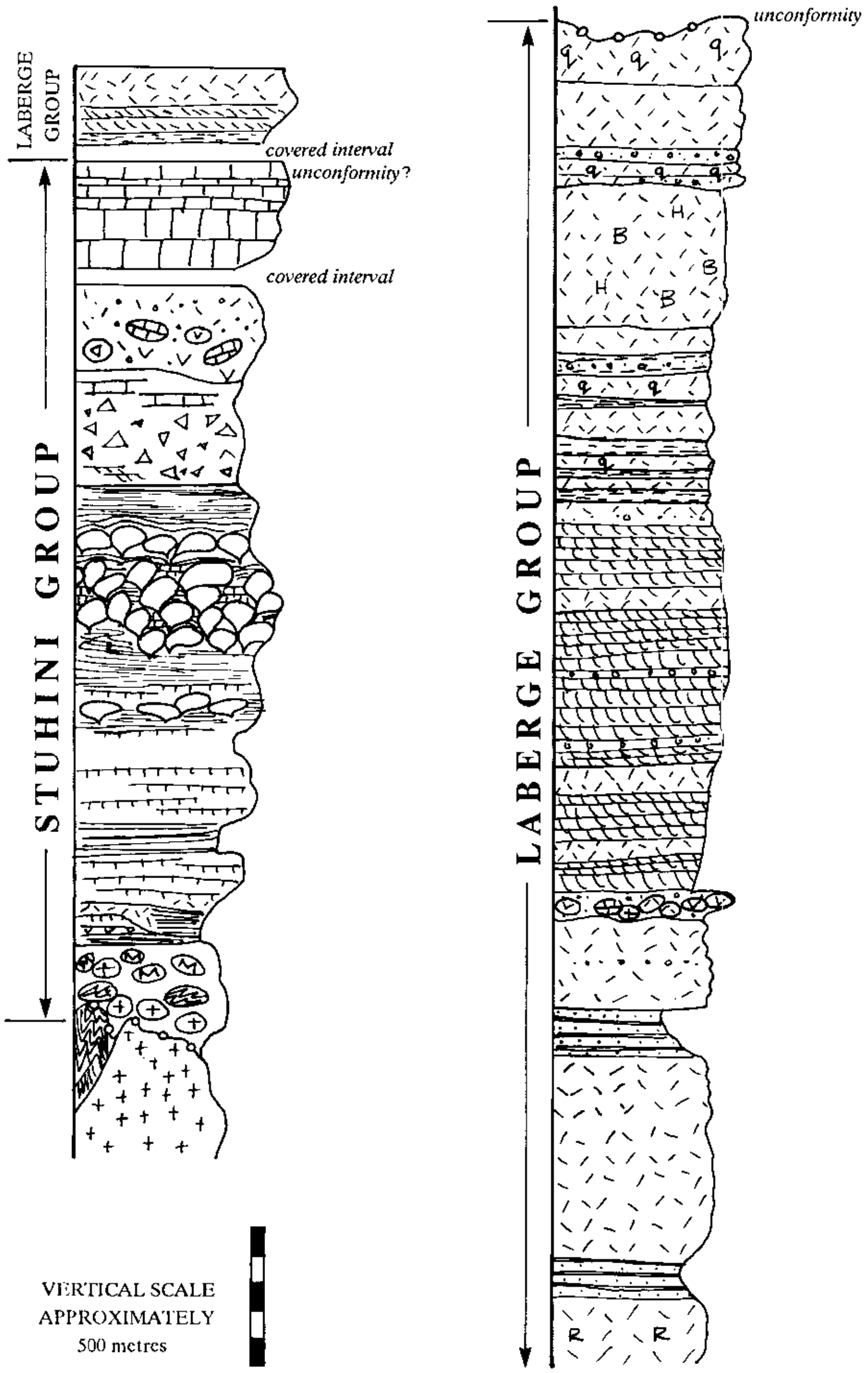


Figure 1-18-3. Generalized stratigraphic columns for the Stuhini and Laberge groups.

shore of Willison Bay a conglomerate unit 500 metres thick is perceptibly zoned; volcanic and intrusive clasts dominate the lower portions whereas metamorphic fragments become more abundant upwards.

Both matrix and clast-supported conglomerates are common. They are normally massive, comprised of lensoid or sheet-like subunits.

SUBAQUEOUS PYROXENE-PHYRIC FLOWS AND INTERLAYERED SEDIMENTS (uTSpx)

Sediments transitional between the conglomerates and this volcanic-dominated unit are generally disrupted, fine-grained, grey-green cherty wackes. They may contain crude layers of andesitic or basaltic blocks (pillow breccia?). At several localities these rocks give way to a pyritic sharpstone conglomerate comprised dominantly of bleached, pebble-sized, angular metamorphic clasts and mica-rich matrix.

Pyroxene-phyric flows (mapped as 'Unit B' by Bultman, 1979) are either massive or pillowed as exposed in resistant, dark grey to black outcrops. Massive flows may be over 20 metres thick, but 2 to 10 metres is more typical. Pillows are generally 0.3 to 2 metres in diameter and commonly have interpillow laminated micrites. Vesicular pillow and flow interiors are plagioclase and pyroxene porphyritic. Locally these rocks are crosscut by gabbroic dikes.

Interlayered argillaceous siltstones drape pillowed flow units; their upper surfaces are disrupted by succeeding volcanic units. Finely ribbed bivalves (*Halobia*?) and carbonized plant material are abundant. These units mark brief episodes of local volcanic inactivity. They are generally less than 3 metres thick and finely parallel bedded (displaying rare ripple cross-stratification). Outcrops are typically rusty and recessive even though the sediments are well indurated with a subconchoidal fracture.

PHREATOMAGMATIC PYROXENE-PHYRIC BRECCIA (uTSpb)

Dusty green, poorly lithified, monolithic breccias form a conspicuous unit above the flows. The change is abrupt, although the actual contact is not exposed. Black pyroxene-rich blocks, set in a matrix of dusty green crystal-ash tuff, range in size up to 0.5 metre, but are generally less than 20 centimetres. These breccias are both clast and matrix supported. These rocks have the same general bulk composition as the underlying unit (uTSpx) and in combination are suggestive of a volcanic pile building to within about 300 metres of the surface where steam generated eruptions occur (Tanakadote, 1935). The abrupt contact between flows and breccias is, however, not supportive of a slowly changing physical condition such as decreasing pressure (water depth) as an explanation for the change in rock type.

Within the map area this lithology is recognized only in the Willison Bay area and corresponds to 'Unit C' of Bultman (1979).

VOLCANICLASTIC UNIT (uTSvc)

Quartz-rich volcanic sandstones crop out at several localities above the pyroxene-phyric breccias, but are not continuous and probably reflect small disconnected basins of deposition. Thickest sections are in central 104M/8 where these rocks attain a thickness of about 800 metres. Planar bedding or shallow, large-scale (several metres) trough crossbedding are common. On southern Copper Island their lower contact is with Unit uTSpb where blocks of the breccia are redeposited with the epiclastics. In upper parts of the unit, carbonate pebbles to large boulders are common, as are crowded feldspar and hornblende porphyry clasts which are lithologically identical to the finer grained parts of the megacrystic hornblende granodiorite. Disrupted, volcaniclast-rich, bioclastic carbonate layers, common within the volcaniclastics, mark the transition to dominantly carbonate sedimentation. Fossils include corallites, colonial corals, bryozoa and bivalves.

SINWA LIMESTONE (uTSs)

These fossil-poor light grey, massive to less commonly well-bedded and argillaceous carbonates have been dated as Late Triassic on the basis of micro and macrofossils. Extensive calcite veining and internal deformation are common, especially in massive beds. This carbonate-rich horizon occurs discontinuously for over 320 kilometres; from a major reef buildup in the Tulsequah map area (type locality; Souther, 1971), through the Tagish Lake area (Bultman, 1979), to patch reefs in Yukon (*e.g.*, Lime Peak; Reid and Tempelman-Kluit, 1987).

The contact between the Upper Triassic Stuhini Group and the Lower Jurassic Laberge Group is most closely constrained on the southwest corner of Copper Island in south Atlin Lake and immediately to the north along the southeast face of the Cathedral. Here greywackes and argillites of the Lower Jurassic Laberge are stratigraphically separated from the Upper Triassic Sinwa carbonate by what is interpreted as a disrupted erosional unconformity. A hiatus is evidenced by disparate ages obtained from fossils in the Sinwa Formation and the overlying Laberge greywackes. The youngest age determination of the Sinwa Formation is uppermost Norian (conodonts from carbonates within 104M/15, identified by M.J. Orchard, Geological Survey of Canada). The oldest fossils collected from overlying Laberge rocks in the area are ammonites of Sinemurian age (identified by H.W. Tipper, Geological Survey of Canada).

GRAHAM CREEK IGNEOUS SUITE AND PENINSULA MOUNTAIN VOLCANIC-SEDIMENTARY SUITE (MGum, MGg; MPv, s)

These rock packages of uncertain age and affiliation crop out between Graham Creek and Sunday Peak in 104M/9. The Graham Creek igneous package includes tectonized harzburgites and gabbros that have a close recurrent spatial relationship with cherts, pillow basalts and succeeding felsic volcanics and epiclastics of the Peninsula Mountain suite. One interpretation of these rock associations is that they represent a dismembered ophiolitic suite, possibly a part of the Cache Creek Terrane.

"Peninsula Mountain" is the name used by Bultman (1979) to describe "a pre-Laberge sequence" of grey-green tuff and tuff breccia and minor, locally interbedded chert and siltstone that crops out along the northeastern edge of the Whitehorse trough and is well exposed on Peninsula Mountain (10 kilometres northwest of Sunday Peak). Since this description closely resembles what is seen in the map area, this terminology has been retained.

Graham Creek igneous rocks have tectonized harzburgite at their base (Plate 1-18-2a) or serpentinite that crops out on the north shore of Graham Inlet 2.5 kilometres east of the mouth of Graham Creek and again along strike in the headwaters of Shaker Creek. Another structurally unrelated sliver occurs on the southeast flank of Sunday Peak. They are bright orange and hackley weathering, strongly sheared and quartz-carbonate-mariposite altered. Maximum thickness is about 30 metres including serpentinized equivalents. Altered gabbros crop out on the southwest flank of Table Mountain structurally above, but not in contact with, the harzburgite.

The Peninsula Mountain volcanic-sedimentary suite sits structurally above the gabbroic rocks. Strongly deformed, well-bedded wackes and cherts are assumed to have a conformable contact with a thick pillow basalt succession since, at two localities, the basalts contain black interpillow cherts.

Contact relationships with the overlying felsic volcanic suite are not easily determined, but intermediate hyaloclastic rocks at the base of the felsic unit suggest initial deposition under subaqueous conditions and felsic volcanism may therefore have been continuous with basalt deposition. The upper volcanics are mainly intermediate to rhyolitic, medium-grained feldspar porphyry breccias and subordinate flows (Plate 1-18-3). Sparse feldspar-biotite ash flows with or without quartz are volumetrically minor but distinct.

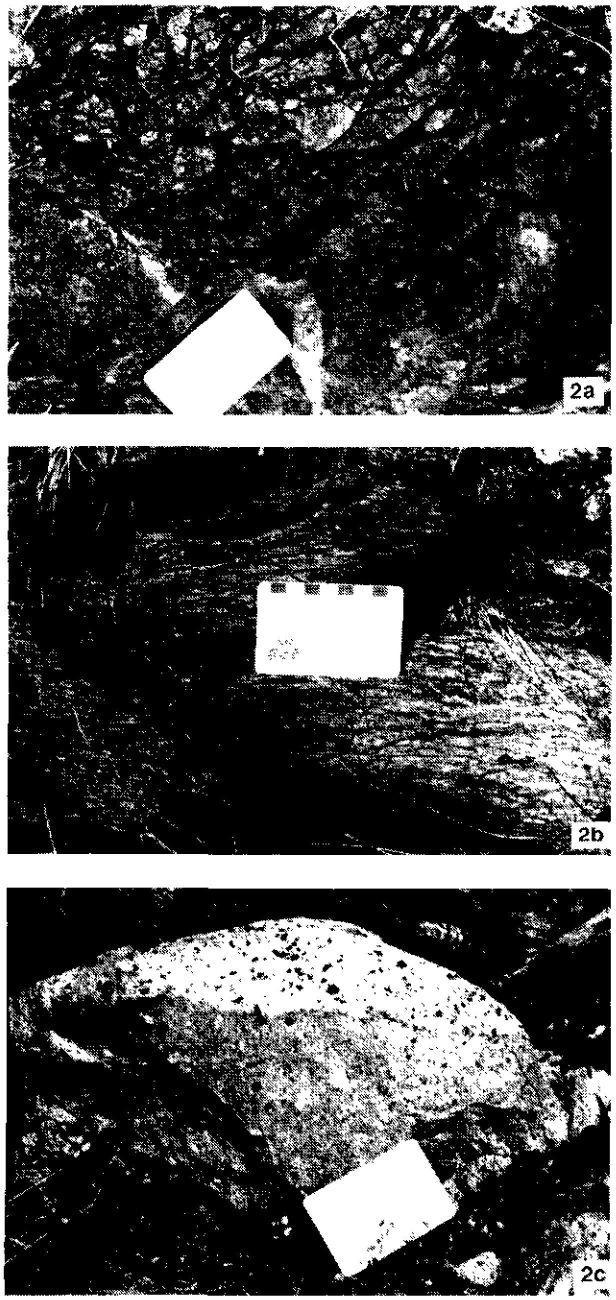


Plate 1-18-2. Mylonitization and admixture of harzburgites shown in (a) with a coarse quartz feldspar porphyry dacitic plug pictured in (c) to produce cataclasite (b).

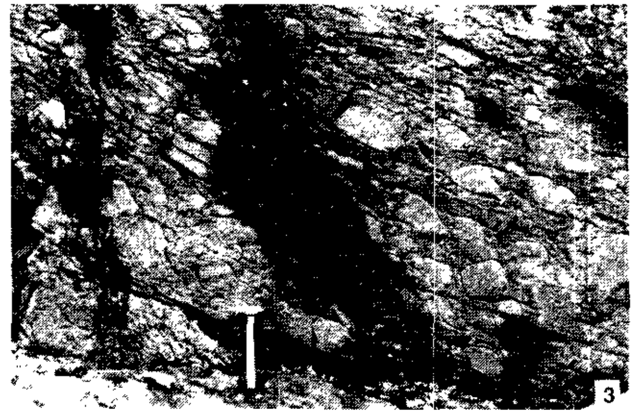


Plate 1-18-3. Coarse, flow-banded rhyolitic feldspar porphyry breccias of the Peninsula Mountain volcanic suite.

LABERGE GROUP (lJL)

Many of the units within the Laberge Group sediments have a limited facies-dependent distribution, which is interpreted to be one of coalescing subaqueous turbidite fans (Bultman, 1979). A ministry project is currently in progress to determine facies and subfacies within these sediments.

ARGILLITES (lJL_a)

Laberge Group argillites are divided into two major types. **Irregular, thinly interbedded** brown to black argillites of variable thickness (most commonly millimetres to decimetres thick) generally occur as sets within wacke-dominated successions. **Rhythmically bedded** argillites form successions low in the Laberge stratigraphy that are 10 to 100 metres or more thick. Beds are 2 to 5 centimetres thick and grade from silty, light-coloured bases to dark, argillaceous tops.

GREYWACKES (lJL_g)

Greywackes are the dominant rock type within the Laberge Group. A major focus of mapping was to divide wackes into feldspathic, quartz-rich and lithic-rich varieties with further subdivisions based on the type and abundance of rock fragments and mafic minerals present.

Feldspathic wackes are the most abundant type and typically occur in massive or well-bedded units with well-defined normal grading. Individual beds vary considerably in thickness, ranging from 5 centimetres to 10 metres or more.

Where bedding is distinguishable, it typically consists of a base of granule conglomerate to very coarse grained wacke with 75 to 90 per cent feldspar grains (the remainder consists of variable amounts of quartz and rock fragments, dominantly altered biotite or hornblende grains, and a muddy matrix) grading upward into a fine to very fine grained feldspathic wacke which rarely exhibits trough cross-stratification and ripples. The weathering colour of feldspathic wackes is a greenish grey or orange and they are resistant compared to adjacent argillite beds which are rusty brown to black.

Lithic-rich wackes are subordinate to feldspathic wackes. They usually occur as beds 10 to 100 centimetres thick, interbedded with argillites (*see* irregularly and thinly bedded argillites above). Overall, lithic-rich wackes are finer and less variable in grain size than feldspathic or quartz-rich wackes.

For a more thorough description of Laberge Group lithologies the reader is referred to Mihalynuk *et al.* (1989a).

TAGISH VOLCANICS (MOUNT SWITZER AND ENGINEER MOUNTAIN SUITES, muKT$_v$)

Rhyolitic through basaltic flows and pyroclastic sequences exist as erosional remnants above metamorphic and trough strata. Contacts are both unconformable and fault bounded. Within 104M/8 these rocks are best exposed in the Mount Switzer and Engineer Mountain areas and, prior to Quaternary erosion, probably blanketed the intervening areas as well. Correlation between the these areas is based upon the common occurrence of two widespread units. **A light green heterolithic lapilli tuff** containing conspicuous white rhyolite fragments up to 15 per cent and variegated aphyric to medium-grained feldspar porphyry clasts. It is recessive and platey weathering. Isolated basalt "blocks" up to 10 metres wide are common and probably represent cross-sections through channelled flows. **Black monolithologic feldspar porphyry breccias and tuffs** are possibly the more widespread unit. They are resistant, weathering into large blocks. Feldspars are medium grained and tan-grey on weathered surfaces.

These rocks are older than the Engineer stock which crosscuts them. This stock is presumed coeval with compositionally similar intrusions (for example, just to the north on Bee Peak) which have yielded a date of 80.3$\pm$2.4 Ma, suggesting that the volcanics are older than Late Cretaceous. South of western Tagish Lake, granites that crosscut the Mount Switzer volcanics have been dated as 64.1$\pm$1.3 Ma (both dates are K-Ar determinations on hornblende separates by Bultman, 1979).

HUTSHI/MOUNT FETTERLY VOLCANICS (muKT$_v$?)

These rocks cap Mount Fetterly and the low mountains to the west. They are probably correlative with the Engineer suite, based upon basaltic flow units that display identical textural and weathering characteristics. At their base, well-developed conglomerates mainly composed of underlying Laberge sediments crop out in paleotopographic lows. Conglomerates grade upwards to olive-green, well-bedded epiclastic rocks rich in plant fossils. Above these are white to rusty weathering, massive, aphyric to quartz and feldspar-phyric rhyolites (at one locality an ignimbrite marks this horizon) that may be several hundred metres thick. Not observed in contact, but presumably overlying, are fractured, brown-weathering, feldspar-porphyritic to aphyric basalts that break to a black, conchoidal surface.

INTRUSIVE ROCKS (oldest to youngest)

VARIABLY FOLIATED HORNBLENDE-RICH GABBRO (lThg)

A strongly foliated to unfoliated diorite to hornblende gabbro crops out on the southwest flank of the Cathedral. In the strongly foliated zones it is reduced to a chlorite schist, but normally surviving igneous textures identify it as a composite intrusive. Abrupt variations in the plagioclase content, on an outcrop scale, and the crosscutting of earlier, more highly foliated zones by less foliated material, indicate emplacement within a structurally active zone at moderate to shallow depth. Intrusives with strikingly similar features occur within the Hogem (Garnett, 1978), Iron Mask (Kwong, 1987) and Copper Mountain (Preto, 1972) bodies; all in the Nicola-Takla-Stuhini belt.

POTASSIUM FELDSPAR MEGACRYSTIC HORNBLENDE GRANODIORITE (lTgd)

Grey-weathering granodiorites, white, pink or tan on fresh surfaces, occur in a linear belt on the eastern side of the Llewellyn fault. These are equivalent to the Bennett Range granite of Hart and Pelletier (1989) which lies to the west of the fault. A weak or, less commonly, moderate foliation is locally developed. Potassium feldspar megacrysts (up to 4 centimetres) may be weakly perthitic and commonly contain concentric zones of plagioclase and hornblende poikilocrysts. According to Hart and Pelletier these rocks can be differentiated from younger granodiorites sharing many of the same characteristics on the basis of the lack of foliation, more perthitic and more lightly coloured megacrysts, and smokey subhedral quartz in the younger rocks.

At its southeastern margin near Splinter Peak, this body loses its holocrystalline texture for a hypabyssal texture with 10 to 15 per cent megacrysts in a matrix of 60 per cent 0.5-centimetre plagioclase phenocrysts and an aphanitic grey to pink groundmass. Volcaniclastic fragments almost identical to these border granodiorites are commonly observed within Unit uTSvc, raising the question of whether the intrusive had extrusive equivalents. If so, then how did these extrusive clasts become entrained high in a stratigraphic pile that sits unconformably above the potassium feldspar megacrystic hornblende granodiorites? Presumably compositionally and texturally similar but younger intrusive bodies had volcanic equivalents.

TECTONIZED WANN RIVER HORNBLENDE DIORITE (Kd)

In the Wann River valley an elongate foliated diorite body crops out for about 500 metres. It is dark green when fresh and white or red on weathered surfaces, with local brittly deformed zones that may be pervasively crosscut by quartz veinlets comprising up to 3 per cent of the rock. It is considered a syntectonic body emplaced along the Llewellyn fault, probably in the Cretaceous, and is perhaps coeval with the diorites described below.

ZONED GRANODIORITE – DIORITE BODIES (lKgd, lKd; CATHEDRAL MOUNTAIN, ENGINEER MOUNTAIN AND SUNDAY PEAK)

A zoned intrusive body, 2 kilometres long, crops out on the southwest flank of Engineer Mountain and a second body, 10 kilometres long, underlies much of the Cathedral. Smaller related dioritic bodies probably include those on the east flank of Engineer Mountain, the south ridge of Bee Peak, Mount Cameron, the east side of southern Edgar Lake and Sunday Peak. A K-Ar (hornblende) age of 80 ± 3 Ma for tonalite from Bee Peak has been determined by Bultman (1979) who included these rocks with intrusives in the Whitehorse trough.

The largest of these bodies contains at least two of the following four phases: an orange-weathering, olive-brown to greasy grey, fresh, medium to coarse-grained hornblende biotite diorite to "anorthositic" biotite diorite, most commonly occurs as a border phase; tan to salmon, platey weathering, sparse potassium feldspar and rare quartz-phyric rhyolite occurs as irregular zones or dike-like bodies with sharp or digested margins; varitextured fine to medium-grained hornblende granodiorite irregularly admixed with the second variety and locally containing abundant biotite-hornblende-rich mafic xenoliths; and white to pink, fine to medium-grained hornblende granodiorite to tonalite with subhedral plagioclase and hornblende (1-5 millimetres and 2-7 millimetres respectively) with mainly interstitial quartz and potassium feldspar. Evenly distributed patches of finely intergrown acicular hornblende and plagioclase 0.5 to 2 centimetres in diameter are characteristic of the Cathedral body.

COAST INTRUSIONS (lKg)

Coast intrusions crop out along the western margin of 104M/8 and were probably emplaced as two separate plutons, one underlying the south end of Tagish Lake and the other in the southwest corner of 104M/8. The south Tagish body is pink to white, medium to coarse grained and may contain up to 5 per cent potassium feldspar megacrysts up to 4 centimetres long. A xenolith-rich chilled margin is observed at the contact with Mount Switzer volcanics. Elsewhere the contact zone lacks xenoliths, but may be peraluminous, bearing 1 to 2 per cent fine garnets. The southwestern pluton is very homogeneous with only the slightest internal variations. It is tan to pink, blocky weathering, medium-grained biotite granite generally containing several per cent perthitic potassium feldspar 1 to 2 centimetres long. At its southeast margin it is in chilled contact with hornblende biotite diorite that forms the northern extension of a large body to the south.

DEFORMATION

FAULTS

The structure of the area is dominated by the northwest trending Llewellyn and Nahlin faults; both involve basement rocks and crop out within the map area as disaggregated brittly deformed zones containing various lithologies and their sheared equivalents.

Several lines of evidence suggest that within the map area the Llewellyn fault is a long-lived, dextral, west-side-up transcurrent structure. It probably acted as a basin-bounding fault to the Whitehorse trough. Uplift on this structure most likely began at least as early as the Triassic, as the metamorphic and igneous source-terrain to the west was exumed to supply detritus to conglomerates of Unit uTSc. A fabric was locally imparted in synkinimatic intrusives such as the variably foliated hornblende-rich gabbros (*see* INTRUSIVE ROCKS) that crop out adjacent to the Llewellyn fault. Latest motion is approximately mid-Cretaceous as it cuts volcanics overlying Lower Jurassic Laberge sediments in the Tutshi Lake area, but is plugged north of the British Columbia-Yukon border by the Pennington pluton (Hart and Pelletier, 1989; Hart, written communication, 1989) which is interpreted to be of Late Cretaceous age.

Metamorphic rocks west of the fault display top-to-the-south, partly annealed, plastic deformation (Plate 1-18-4a, b). A later dextral and east-side-down brittle deformation also affects the rock (Plate 1-18-4c). This late event is probably related to motion on the Llewellyn fault, but its age is not known. An undeformed pegmatite is both crosscut and invades these minor fault planes.

Three surface exposures of highly deformed rocks, including tectonized harzburgite, are interpreted to lie along the trend of the Nahlin fault within 104M/9E (except at Sunday Peak). Fabrics within this zone are all near vertical and strike 120°. Well-developed shear bands in a mylonite zone (Plate 1-18-2b) indicate local intense cataclasis. Shear sense, however, could not be unequivocally determined because of the lack of a consistent lineation. This fault crosscuts the Laberge and Graham Creek rocks and is plugged by the Birch Mountain pluton which has yielded K-Ar ages of 56 ± 6 and 48 ± 3 Ma (on biotite and hornblende respectively; Bultman, 1979).

FOLDS

Folding affects all pre-Cretaceous rocks in the map area. Megascopic folds in all major lithologies, except the chlorite-actinolite schists of the Boundary Ranges metamorphic suite, are dominated by upright to overturned, open to closed and gently plunging fold styles. These generally have northwest-trending axial surfaces (Figure 1-18-4). Mainly east-trending, broad folds affecting the Laberge Group rocks are thought to postdate the northwest folds, but these structures are poorly known.

METAMORPHISM

Nine samples containing garnet and biotite were selected from the low-grade zone within the 1988 map area for the

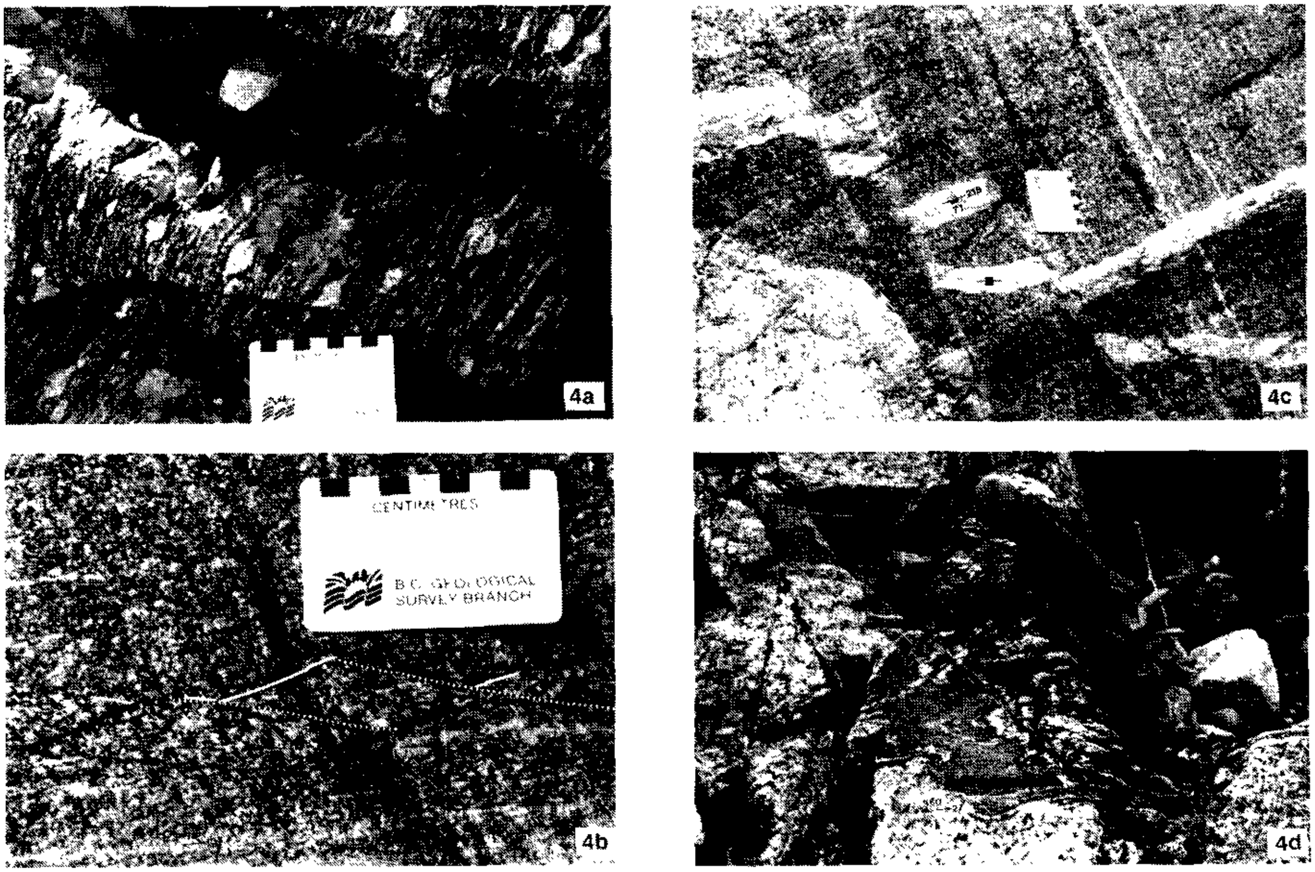


Plate 1-18-4. Deformation within the Hale Mountain hornblende granodiorite: (a) sigma-type augen indicating top-to-the-left (south) motion. A well-developed mineral lineation outlined by hornblende is approximately parallel to the outcrop surface (view is to the west, the foliation is 135/70); (b) synthetic (dashed) and antithetic (dotted) fault surfaces in coarse Hale Mountain intrusive phase are consistent with a sinistral shear sense; (c) pervasive brittle faults show east-side-down and dextral displacement; (d) mafic-rich layers within the Hale Mountain intrusive locally display tight to isoclinal folds with axes parallel to the regionally developed mineral lineation (here 350/27).

purpose of Fe-Mg exchange geothermometry. Thin-section studies show that four of these samples are too retrograded to be worth analyzing. Microprobe analyses were conducted on the remaining five samples (Table 1-18-1), but one of them yielded biotites with low K_2O and high SiO_2; clearly altered and unlikely to produce meaningful temperatures (not listed in Table 1-18-1). In all cases, the samples displayed some degree of replacement of biotite by chlorite. One sample (MM 27-6) contained mainly unaltered biotites. In another sample (MM 11-1), the analysis of garnet and biotite in textural equilibrium was not possible. Calculated temperatures based on the calibration of Ferry and Spear (1978) and Thompson (1976) and the average composition of garnet-biotite pairs, yields a systematic core-to-rim temperature decrease from 592°C (576°C) to 557°C (547°C) for MM 27-6. In sample MM 11-1, analyses of garnet rims and isolated interstitial biotite grains ('INTER' on Table 1-18-1) yielded temperatures of 562°C (551°C). Both LC 11-1A and MM 14-2B yield similar temperatures. However, these temperatures should only be considered approximate as the titanium-aluminum content of the biotites and the calcium-manganese content of the garnets fall outside the compositional limits that are considered to be a reliable uncorrected biotite-garnet geothermometer. Actual temperatures probably fall within the ±75°C error limits of the Ganguley and Saxena (1984) 'corrected' geothermometer which, although not tabulated in Table 1-18-1, were calculated and found to be 20° to 70°C higher than the temperatures obtained from the Thompson calibration (in parentheses). In any case, such temperatures indicate amphibolite-grade metamorphism; they are incompatible with the greenschist to transitional greenschist-amphibolite grades implied by the present mineral assemblage.

Low-grade metamorphic minerals, particularly chlorite and actinolite, display both syn and predeformation textures in that they may be aligned or bent by the last phases of folding. Late folds (F_3 of Mihalynuk *et al.*, 1988b, 1989a) within the metamorphic rocks are approximately coplanar with the main phase of folding within the Laberge Group strata of the Whitehorse trough (Figure 1-18-4). Similarly, near the British Columbia–Yukon border, metamorphic rocks and unconformably overlying Laberge sediments are folded together about an axis parallel to the Whitehorse trough structural grain. Unless these folds have been transposed, F_3 could be of Middle Jurassic to Early Cretaceous age. [Volcanics interpreted to rest disconformably atop Toarcian sediments are folded, but younger Montana Mountain volcanics (*circa* 90 Ma, Hart and Pelletier, 1989) apparently

TABLE 1-18-1
COMPOSITIONS OF (A) BIOTITE AND (B) GARNET FROM BOUNDARY RANGES METAMORPHIC SUITE RETROGRADED GARNET-BIOTITE-MUSCOVITE-CHLORITE-ACTINOLITE SCHISTS.

Table 1-18-1a MICROPROBE ANALYSES: BIOTITE

SAMPLE		LC11-1A		MM11-1	MM14-2B		MM27-6		
N		5	6	5	10	4	4	4	4
place		RIM	INTER	INTER	RIM	INTER	CORE	MIDDLE	RIM
WEIGHT PER CENT OXIDES									
Oxide	DL								
SiO2	0.06	34.75	34.50	36.02	35.47	36.51	35.87	35.91	35.91
TiO2	0.03	1.39	1.28	1.72	1.41	1.42	2.79	2.78	1.69
Al2O3	0.07	17.43	17.28	17.16	18.11	18.09	17.04	17.00	17.03
FeO*	0.04	23.31	23.05	21.47	23.22	22.50	22.57	21.98	20.98
MnO	0.05	0.10	0.10	0.07	0.12	0.10	0.34	0.25	0.28
MgO	0.03	10.50	10.87	10.42	8.98	8.84	8.35	9.23	9.94
CaO	0.01	0.07	0.06	0.02	0.04	0.18	0.10	0.05	0.05
Na2O	0.02	0.21	0.11	0.16	0.03	0.28	0.03	0.03	0.05
K2O	0.01	8.00	7.99	9.19	8.76	8.98	9.43	9.47	9.64
BaO	0.11	0.00	0.00	0.20	0.00	0.00	0.39	0.35	0.36
Cl	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F	0.05	0.18	0.20	0.21	0.22	0.23	0.19	0.19	0.21
Total		**95.93**	**95.44**	**96.64**	**96.36**	**97.13**	**97.10**	**97.24**	**96.14**
					(anhydrous)				
NUMBER OF ATOMS BASED ON 12 O + (OH+F+Cl)									
Si		5.40	5.39	5.54	5.49	5.59	5.54	5.52	5.57
Ti		0.16	0.15	0.20	0.16	0.16	0.32	0.32	0.20
AlIV		2.60	2.61	2.46	2.51	2.41	2.46	2.48	2.43
AlIII		0.59	0.57	0.65	0.80	0.85	0.64	0.60	0.68
Fe*		3.03	3.01	2.76	3.01	2.88	2.92	2.83	2.72
Mn		0.01	0.01	0.01	0.02	0.01	0.04	0.03	0.04
Mg		2.43	2.53	2.39	2.07	2.02	1.92	2.12	2.30
Ca		0.01	0.01	0.00	0.01	0.03	0.02	0.01	0.01
Na		0.06	0.03	0.05	0.01	0.08	0.01	0.01	0.02
K		1.59	1.59	1.80	1.73	1.75	1.86	1.86	1.91
Ba		0.00	0.00	0.01	0.00	0.00	0.02	0.02	0.02
OH		3.63	3.65	3.60	3.62	3.58	3.61	3.59	3.62

Biotite-garnet Fe-Mg exchange thermometer results are listed at the bottom of (b).

Table 1-18-1b MICROPROBE ANALYSES: GARNET

SAMPLE		LC11-1A		MM11-1			MM14-2B		MM27-6		
N		6	8	4	4	5	2	8	4	4	4
place		MIDDLE	RIM	CORE	MIDDLE	RIM	MIDDLE	RIM	CORE	MIDDLE	RIM
WEIGHT PER CENT OXIDES											
Oxide	DL										
SiO2	0.06	36.95	37.15	37.66	37.56	37.13	36.98	37.02	37.23	37.4	37.31
TiO2	0.03	0.08	0.06	0.10	0.06	0.04	0.16	0.08	0.25	0.21	0.13
Al2O3	0.08	20.76	20.97	20.83	20.91	20.62	21.03	21.17	20.65	20.43	21.08
FeO	0.04	31.77	31.96	29.99	31.17	31.90	30.43	31.96	27.49	27.94	28.66
MnO	0.06	3.04	2.35	4.60	3.44	2.81	3.93	2.12	5.27	4.28	2.98
MgO	0.02	2.37	2.60	2.40	2.62	2.61	1.94	2.37	2.00	2.10	2.27
CaO	0.01	4.68	4.57	5.15	4.96	4.54	5.47	4.97	6.81	7.16	7.43
Total		**99.64**	**99.66**	**100.73**	**100.72**	**99.65**	**99.92**	**99.69**	**99.70**	**99.52**	**99.66**
NUMBER OF ATOMS BASED ON 12 O											
Si		2.99	2.99	3.01	3.00	3.00	2.98	2.98	3.00	3.01	2.99
Al		1.98	1.99	1.96	1.97	1.96	2.00	2.01	1.96	1.94	1.99
Ti		0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.02	0.01	0.01
Fe2		2.15	2.15	2.00	2.08	2.15	2.05	2.15	1.85	1.88	1.92
Mg		0.28	0.31	0.29	0.31	0.31	0.23	0.28	0.24	0.25	0.27
Mn		0.21	0.16	0.31	0.23	0.19	0.27	0.14	0.36	0.29	0.20
Ca		0.41	0.39	0.44	0.42	0.39	0.47	0.43	0.59	0.62	0.64
Fe3+		0.02	0.01	0.04	0.03	0.04	0.00	-0.01	0.04	0.06	0.01
MOLE FRACTION END MEMBERS											
Xalm		0.70	0.71	0.66	0.68	0.70	0.68	0.72	0.61	0.61	0.63
Xprp		0.09	0.10	0.09	0.10	0.10	0.08	0.09	0.08	0.08	0.09
Xsps		0.07	0.05	0.10	0.08	0.06	0.09	0.05	0.12	0.10	0.07
Xgrs		0.13	0.13	0.13	0.13	0.12	0.16	0.15	0.18	0.19	0.21
Xadr		0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.00

GEOTHERMOMETRY RESULTS

	LC11-1A		MM11-1			MM14-2B		MM27-6		
lnKD	-1.87	-1.71	-1.79	-1.74	-1.77	-1.74	-1.66	-1.67	-1.70	-1.78
Thompson**	526*	565	545*	557*	551*	558*	578	576	568	547
Ferry and Spear	529*	582	548*	570*	562*	572*	599	592	585	557

N = NUMBER OF ANALYSES (AVERAGED); DL = DETECTION LIMIT

* Temperature in degrees celsius resulting from mineral pairs that DID NOT grow in textural equilibrium (i.e. biotite is interstitial (INTER) and isolated from the garnet)

** *Thompson calibration with pressure correction of 4kilobars used*

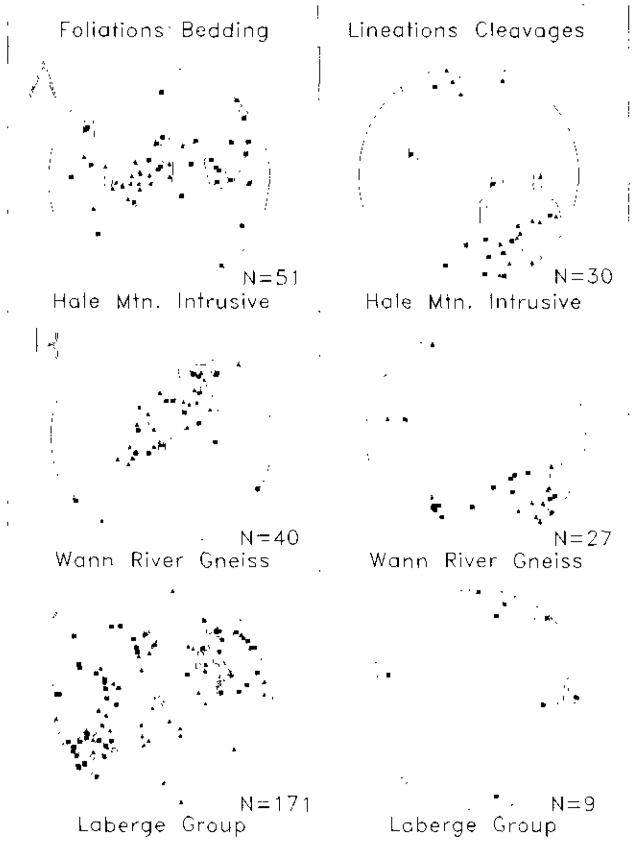


Figure 1-18-4. Lower hemisphere stereo plots showing foliations and mineral lineations within (a) the Hale Mountain granodiorite and (b) the Wann River gneiss and (c) poles to bedding and cleavages within the Laberge Group. Contour interval is five per cent per one per cent area.

are not. F_1 and F_2 must be pre-Late Triassic because foliated metamorphic clasts are found within conglomerates of that age.] F_3 deformation may affect rocks in the chlorite schist package more strongly due to the proximity of the Llewellyn fault, which in combination with extensive plutonism to the west, probably acted as a conduit supplying enough heat-driven fluids to retrograde the region and to facilitate deformation. It is doubtful whether all low-grade metamorphic rocks are a result of retrogression, at least not a retrograde event of post-Middle Jurassic age, since chlorite-muscovite-quartz schists occur as clasts within Upper Triassic conglomerates in the Llewellyn Inlet area.

MINERALIZATION

Exploration activity has increased dramatically in the Tagish Lake area in 1989 (Figure 1-18-5).

Six distinct types of mineralization are recognized within the study area. Occurrences include past producers such as the Engineer mine, a sulphide-poor gold and gold-tellurium-silver-bearing quartz vein and the Ben-My-Chree sulphide-rich gold-silver-bearing quartz vein. Others include gold ± silver quartz veins with no sulphides, as at the Sweepstake showing; sulphide-bearing calcite and/or quartz veins, and massive sulphide pods like the Anyox-Rodeo showing. The association of carbonatized ultramafic rocks and gold, characteristic of the Atlin camp, may also apply to the Graham Creek area. Quartz-carbonate-mariposite-altered ultramafics crop out within this drainage, which is the westernmost placer stream of the Atlin camp.

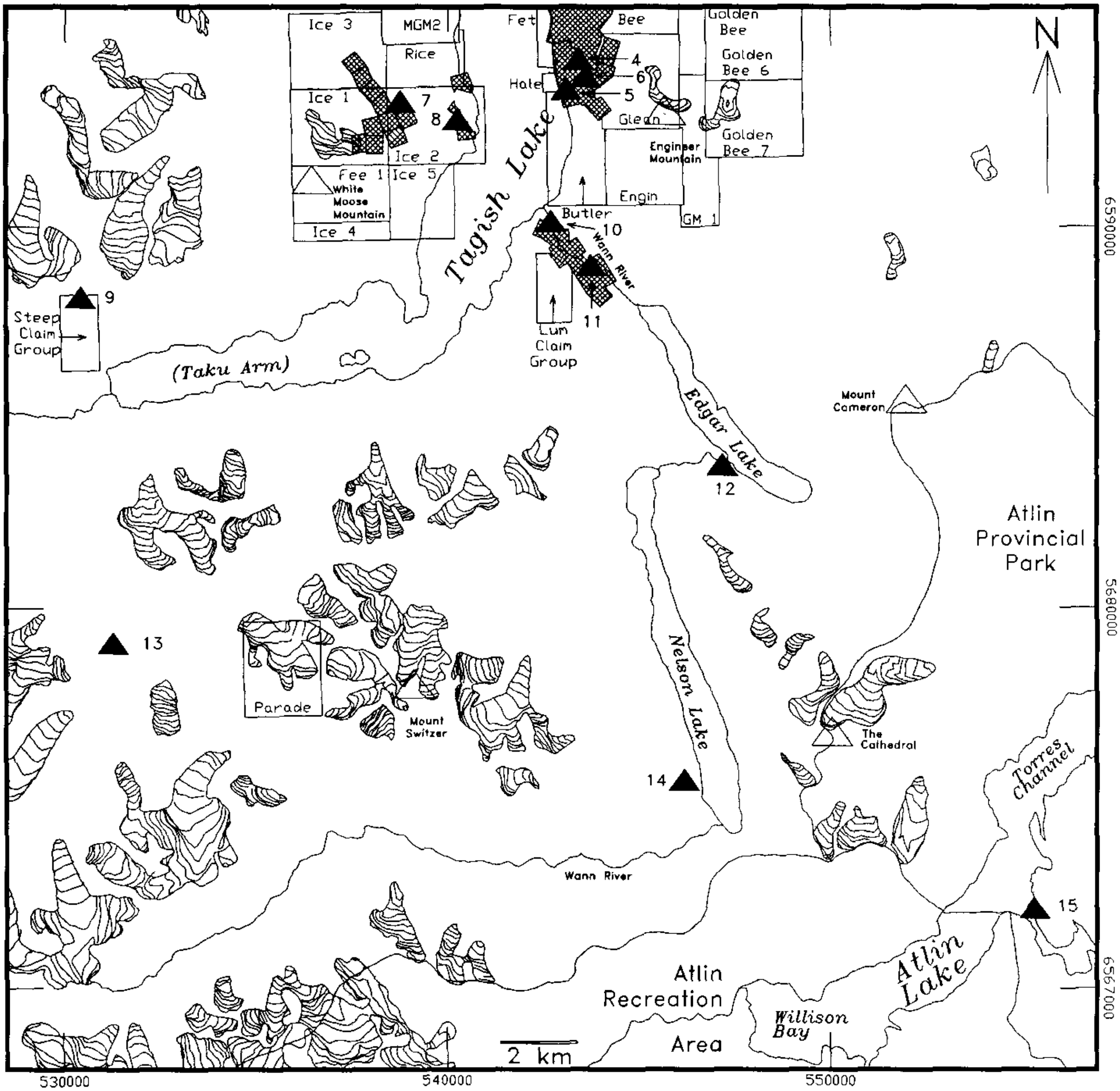


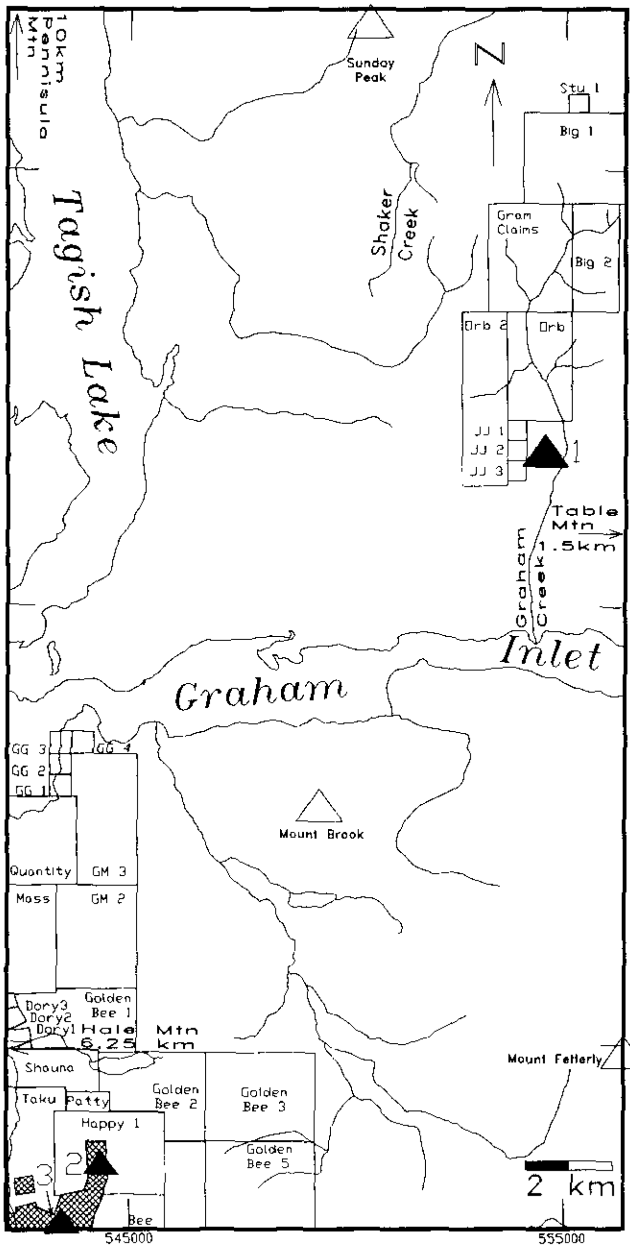
Figure 1-18-5. Claim boundaries as shown on September, 1989 mineral claims map. MINFILE occurrence locations denoted by solid triangles, numbers correspond to those in Table 1-18-2. Crown grants are denoted by the cross-hatched pattern.

Gold and Gold-Tellurium-Bearing Quartz Veins with Trace Base Metals

Historically the Engineer mine is the largest lode gold producer in the area, yielding approximately 560 kilograms of gold with an average recovered grade of 36 grams per tonne between 1913 and 1952. Native gold, tellurides, pyrite and traces of allemontite (SbS), arsenopyrite, mariposite and berthierite needles (FeS-Sb_2S_3), identified by x-ray analysis, occur in quartz-calcite veins. Good comb structures as well as banding and vugs characterize these veins which crosscut Lower Jurassic Laberge argillites and greywackes (Schroeter, 1986).

The Gleaner, Lumsden, Myosotis, Lake View and Taku Chief gold vein occurrences are similar mineralogically and geologically to the Engineer mine and are included as part of the Engineer system (Table 1-18-2).

The Happy Sullivan prospect has a similar mineralogical and geologic setting to that of the Engineer mine, however, arsenopyrite is locally up to 20 per cent and dendritic crystals



of native gold have been found (Table 1-18-2; Schroeter, 1986).

Gold-Silver Quartz Veins and/or Brecciated Zones with Base Metals

Although showings of this type have received significant exploration and development work, historically they have been uneconomic. This mineral occurrence type comprises about one half of all mineral occurrences in the 104M/8 and M/9 map areas (Table 1-18-2) and is restricted to areas adjacent the Llewellyn fault zone (Figure 1-18-5). These occurrences include veins on the White Moose, Rupert and Steep claim groups and the Kim and Nelson Lake showings. Significant associated minerals are galena, chalcopyrite, malachite, pyrite (with or without bornite, tetrahedrite, azurite and pyrrhotite) with minor native gold and silver. Veins on the White Moose and Rupert claim groups crosscut Boundary Ranges metapelites whereas those on the Steep claim group (with up to 450 grams per tonne gold) are hosted by Late Cretaceous granites, as at the Nelson Lake showing.

Gold(± Silver) Quartz Veins without Base Metals

Veins at the Kirtland and Jersey Lily showings are of this type. They differ from the Engineer veins in that they contain gold and silver but lack tellurides and base metals. Veins at the Kirkland occurrence are just south of the Engineer vein system. The Sweepstake occurrence also shows similar mineralogical and geological characteristics, but differs in that the veins contain no silver.

Base Metal Veins within the Llewellyn Fault Zone

The Brown, Jack Pine, Wann Fraction and Anyox-Rodeo showings are base metal occurrences within the Llewellyn fault zone. An adit 10 metres long, driven along the Brown vein, exposes an anastomosing network of irregular quartz veins and veinlets, ranging from less than 1 to 35 centimetres wide, parallel to the country rock foliation (which is oblique to the main trace of the fault). Gouge material ranges from Boundary Ranges chlorite-actinolite schists to altered granodiorite and Stuhini volcanics. Mineralization consists of tetrahedrite, chalcopyrite, malachite, azurite, molybdenite pyrite, sphalerite and galena.

Massive Sulphides within the Llewellyn Fault Zone

The Anyox-Rodeo showing is a copper-nickel-platinum-palladium massive sulphide occurrence hosted in Boundary Ranges chlorite-actinolite schist near its contact with probable Upper Triassic Stuhini volcanics. Fractured actinolite porphyroblasts up to 3 centimetres long are accompanied by interstitial or fracture-filling pentlandite, pyrrhotite chalcopyrite and pyrite. Anomalous platinum and palladium analyses have been reported but have not been confirmed.

Placer

The Graham Creek placer claims are the westernmost known occurrence of placer gold in the Atlin and Tagish Lakes area. Property exploration and development to date have not yielded substantial returns. Extensive geochemical analysis of water samples collected from the Graham Creek drainage basin has consistently yielded anomalous values in gold (1 to 7 parts per trillion). Furthermore, nickel tellurides, chromite and gold grains (with electrum) have been recorded from heavy mineral separates (B. Ballantyne, Geological Survey of Canada, personal communication, 1989; *see* also Hall *et al.*, 1986). Silt samples may yield anomalous arsenic values, but not necessarily with accompanying high gold. Soil samples are generally anomalous with respect to lead. According to Ballantyne, these geochemical observations

TABLE 1-18-2
MINFILE OCCURRENCES

MAP. NO	NAME (MINFILE NUMBER)	COM-MODITY	ASSAY (Reference)	SAMPLE WIDTH	DESCRIPTION
1	Graham Creek (104M 023)	Au			Westernmost placer gold occurrence of the Atlin gold camp.
2	Happy Sullivan (104M 013)	Au Ag	323.6 g/t 226.2 g/t (AR 10511)	Grab	Mineralized quartz veins, up to 0.9 m wide, are located within a shear zone about 24 m wide and 3 km long in Lower Jurassic Laberge greywackes and argillites.
3	Sweepstake (104M 025)	Au	n.a.		
4	Engineer Mine (104M 014)	Au Ag Sb Te	past producer (1913-1952) 15 564 tonnes grading 36.0 g/t Au 17.9 g/t Ag		Sporadic mineralization, mainly gold, occurs in discordant quartz-calcite veins less than 2 m wide. Veins are hosted in Laberge greywacke and argillite and are oriented oblique to local and regional northwest-trending folds.
5	Engineer gold camp Kirkland Group (104M 015)	Au Ag	n.a.		Veins on the Kirkland group are a southerly extension of the Engineer vein system. The main vein, the Jersey Lily, is about 60 cm wide, composed of quartz and minor gold. It is hosted in Laberge sediments.
6	Engineer gold camp Gleaner Group (104M 016)	Au Ag Te	n.a.		Gleaner veins are situated on the northeast side of a major northwest-trending shear zone. Pyrite and gold are hosted in brecciated quartz stringers up to 1.2 m wide.
7	Rupert claim group (104M 008, 35, 36 and 37)	Au Ag Pb Cu Zn	7.6 g/t 925 g/t 74 % 0.28 % 860 g/t (KMO89-47-1)	Grab from 'G' occurrence	Mineralized quartz veins occur near the contact between Hale Mountain meta-intrusive and the metavolcano-sedimentary Wann River gneiss suite. Veins are frequently subparallel to, or bounded by, felsite dykes.

can be explained by the occurrence of a hydrothermal system (such as that producing the silica-flooded rhyolite breccia in Graham Creek) rooted in mafic and ultramafic lithologies such as those exposed both east and west of Graham Creek.

MINERAL POTENTIAL

A number of geologic environments indicate good potential for precious metals. Several of these have been stressed in Mihalynuk *et al.* (1989a), however, subsequent regional mapping has refined the earlier analysis and indicated other favorable geologic environments, as follows:

(1) Veins hosted by Laberge Group strata and associated with splays of the Llewellyn fault zone and/or adjacent dioritic intrusions and volcanics as at the old Engineer mine. Such veins may core folds in the Laberge strata. Further prospecting in the area should place emphasis on the relationships between these features.

(2) Both concordant and discordant (with respect to the foliation) quartz veins occur in the Paleozoic-Proterozoic Boundary Ranges metamorphic rocks. Exploration for occurrences of this type requires a careful focus on late crosscutting metal-bearing veins as barren, concordant quartz sweats are abundant.

(3) Sheared and altered (broadly silicified) or quartz veined rocks within and adjacent to the Llewellyn fault zone are known to be anomalous in gold (Mihalynuk and Rouse, 1988a, b; Mihalynuk *et al.* 1989b).

(4) Brecciated contacts between an en echelon belt of Late Cretaceous to Early Tertiary(?) volcanics and Paelozoic-Proterozoic Boundary Ranges metamorphic rocks including the Teepee Peak and Mount Switzer volcanics.

(5) Mafic and ultramafic rocks occurring adjacent to major fault structures or capped by volcanics have precious metal potential.

(6) Calcsilicate rocks within the Florence Range metamorphic suite locally display sulphide potential. Loose boulders of calcsilicate containing sphalerite and galena (up to 5 per cent) were traced to the base of steep outcrops.

8	White Moose claim group (104M/009, 10, 12)	Au Ag Pb Cu Zn	2.06 g/t 27.4 g/t 2.45 % 0.01 % (AR 8384)	Grab	Mineralized quartz veins occur in Proterozoic to Paleozoic Boundary Ranges greenschist, Hale Mountain meta-intrusive and Wann River gneiss. Veins range from 0.4 to 1.2 m wide.
9	Steep claim group (104M 011)	Au Ag Pb Cu Zn	450.0 g/t 11.0 g/t 4.2 % 0.1 % (AR 9133)	Grab (best assay)	Mineralized quartz-calcite veins are hosted in Cretaceous granite of the Coast plutonic suite. Ore shipped in 1911 yielded 31 103 grams of silver and 93 grams of gold.
10	Brown, Jackpine, Wann Fraction (104M 026)	Au Ag Pb Cu Zn	17.9 g/t 347 g/t 2.62 % 0.56 % 1.00 % (MMI89-59-2A)	Grab (best assay)	A series of subparallel to parallel anastomosing mineralized quartz veins up to 35 cm thick occur within a major splay of the Llewellyn fault zone over more than 70 m. Host rocks are meta-intrusive and metasedimentary lenses.
11	Anyox-Rodeo (104M 017)	Cu Ni Pt Pd Co	0.15 % 0.60 % n.a. n.a. 0.12 % (KMO89-26-3)	Grab	A massive copper-nickel sulfide occurrence is hosted in chloritic schists of probable Proterozoic to Paleozoic age, which lie within major splay of the Llewellyn fault zone.
12	Edgar Lake (104M 018)	Cu	n.a.		Native copper occurs in a number of calcite veins and as disseminations in pyroxene-phyric lapilli tuffs of the Stuhini Group.
13	Kim (104M 063)	Ag Au Cu	109.7 g/t 0.7 g/t 4.0 % (EMPR property file)	Grab	Mineralization occurs in one of several poorly exposed shear zones in a granodiorite host.
14	Nelson Lake (104M 019)	Au Ag Pb Cu	4.6 g/t 198 g/t 3.9 % 1.25 % (MMI89-62-1)	Grab	Highly deformed pelitic schists and marbles host these sulphide-rich veins.
15	Copper Island (104M 020)	Cu	n.a.		Native copper and associated oxides occur in calcite veins.

Occurrence locations are shown on Figure 1-18-5.

ACKNOWLEDGMENTS

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