GEOLOGY AND MINERALIZATION OF THE STUHINI CREEK AREA (104K/11)

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KEYWORDS: Stuhini Creek, Tulsequah, Stikine assemblage, Stuhini Group, Laberge Group, Sloko Group, Eocene deformation, copper, gold, lead, provenance, ammonite biostratigraphy

INTRODUCTION

Regional geologic mapping in 1994 extended previous 1:50 000-scale mapping of the Tulsequah River mapsheet (104K/12; Mihalynuk *et al.*, 1994a, b) eastward into the Stuhini Creek map area (104K/11, Figure 1). Approximately 20% of the Tulsequah River and 45% of the Stuhini Creek map sheets has been previously mapped as Upper Triassic Stuhini Group (Souther, 1971). More recently, fossil and isotopic age data indicate that most "upper Triassic" rocks within the Tulsequah River map area are in fact Paleozoic (Nelson and Payne; 1984; Mihalynuk *et al.*, 1994a; Sherlock *et al.*, 1994), including rocks that host two past-producing volcanogenic massive sulphide deposits, the Big Bull and Tulsequah Chief. A primary objective of fieldwork in 1994 was to search along strike in 104K/11 for correlative Paleozoic strata, in large areas previously identified as Stuhini Group. Other objectives included identification of potential for shallow submarine hydrothermal mineralization in fine Stuhini Group clastics (e.g. Eskay Creek style) and evaluation of potential for gold mineralization in east-west cross faults.

PREVIOUS WORK

Mineral exploration in the area dates back to at least 1923 with discovery of the Tulsequah Chief deposit. However, systematic regional mapping was not begun until Kerr's investigations in 1930 and 1932 (Kerr, 1931a, b, 1948). In 1958 to 1960 Souther (1971) completed 1:250 000-scale mapping of the Tulsequah area. Monger (1980) mapped parts of the northern Stuhini Creek area, with a focus on Upper Triassic stratigraphy. Geological mapping since that time has been primarily restricted to company reports with limited distribution. Maps produced by Cominco Ltd. (Payne and Sisson, 1988) cover a large part of 104K/12. Regional surveys by Anglo Canadian Mining Corporation (Payne *et al.*, 1981) touched on isolated parts of 104K/11, but were published at very small scale in largely schematic form (Nelson and Payne, 1984).

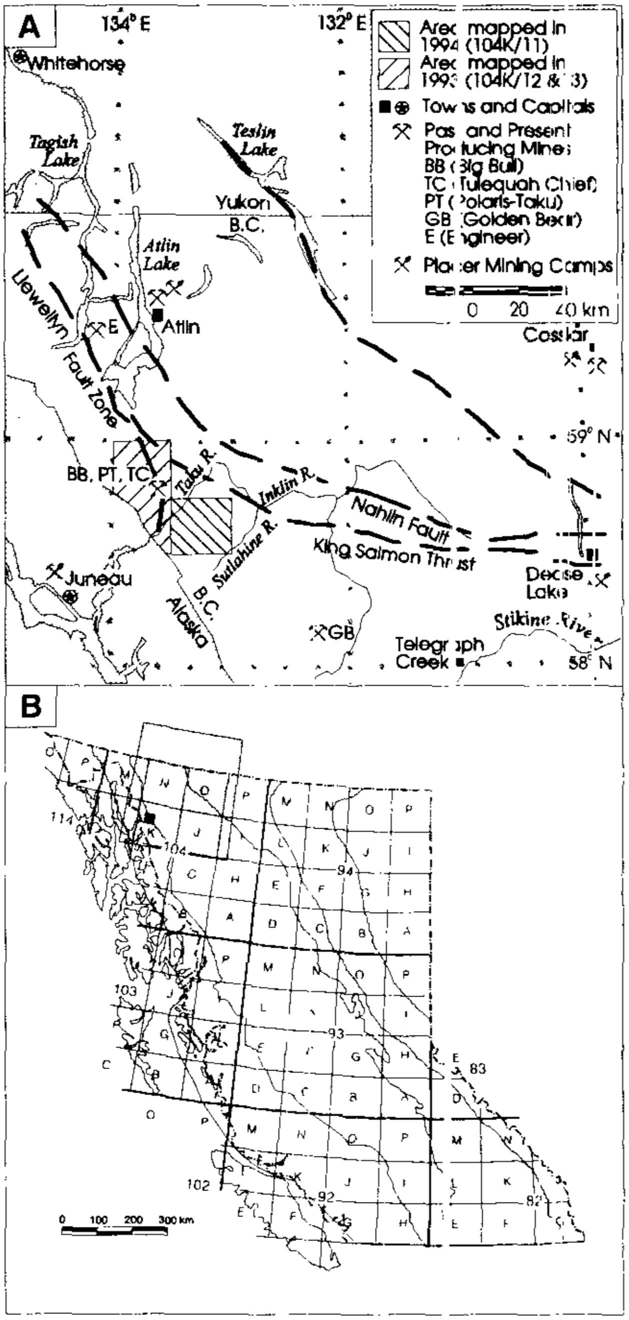

Figure 1. (a) Location of the Tulsequah project showing prominent geographic and cultural features. (b) Location of the map area within the National Topographic System. Tectonostratigraphic belts are also outlined.

LOCATION, PHYSIOGRAPHY AND ACCESS

Stuhini Creek map area covers about 800 square kilometres of the Coast Mountains, centred 75 kilometres northeast of Juneau, Alaska and 100 kilometres south of Atlin, British Columbia (Figure 1). Braided channels and flanking sloughs of the southwest-flowing Taku River occupy a swath 2.5 kilometres wide in the northwest corner of the map area. West-flowing Stuhini Creek, formerly known as the "South Fork of Taku River" (*cf.* Mandy, 1930), drains about 30% of the map area. Stuhini Creek and major parallel drainages north and south, the Sittikanay River and Zohini Creek respectively, are deeply incised, and meet the Taku River on grade. Other streams occupy U-shaped hanging valleys and freefall into the Taku River. Such streams are in turn, commonly fed from hanging valleys. Travel from one valley to the next is often not possible without technical climbing. Mount Lester Jones, on the northern edge of the map area, marks the division between rugged, glaciated Coast Mountains and relatively gentle, dry Stikine Plateau uplands.

Rock and temperate rainforest comprise roughly equal proportions of the Stuhini Creek area, with about 5% outcrop beneath forest canopies. Areas of 100 % cover are restricted to glaciers, river bottoms and swamps which collectively amount to about 15% of the area. Geological fieldwork is challenged by steep topography, snow and ice cover, dense brush in major valley bottoms and generally poor weather, but the summer of 1994 was drier than usual.

Access to the region is either by fixed or rotary-wing aircraft or by shallow-draft boat or barge up the Taku River. Nearest centres for aircraft charter are Atlin and Juneau, although helicopters are intermittently based in the Tulsequah valley. Two gravel airstrips are serviceable. Northwest of the confluence of the Taku and Tulsequah rivers, a strip more than a kilometre long will accommodate a DC-3 or Caribou aircraft, but is subject to flooding two or more times each summer. A less flood prone, much shorter strip at the Polaris-Taku minesite will accommodate small aircraft or those with short take-off capability. There are no roads or established trails within the map area; travel from airstrips to other localities is most effectively done by helicopter.

GENERAL GEOLOGIC AND TECTONIC SETTING

Four major building blocks constitute the terrane superstructure of northwestern British Columbia (Figure 2): a western block of polydeformed, metamorphosed Proterozoic to middle Paleozoic pericontinental rocks (Nisling assemblage (of Yukon Tanana Terrane as used by Mortensen, 1992)); an eastern block of exotic oceanic crustal and low-latitude marine strata (Cache Creek Terrane of Coney *et al.*, 1980); central blocks including Paleozoic Stikine assemblage (Monger, 1977; Brown *et al.*, 1991) and Triassic arc-volcanic and flanking

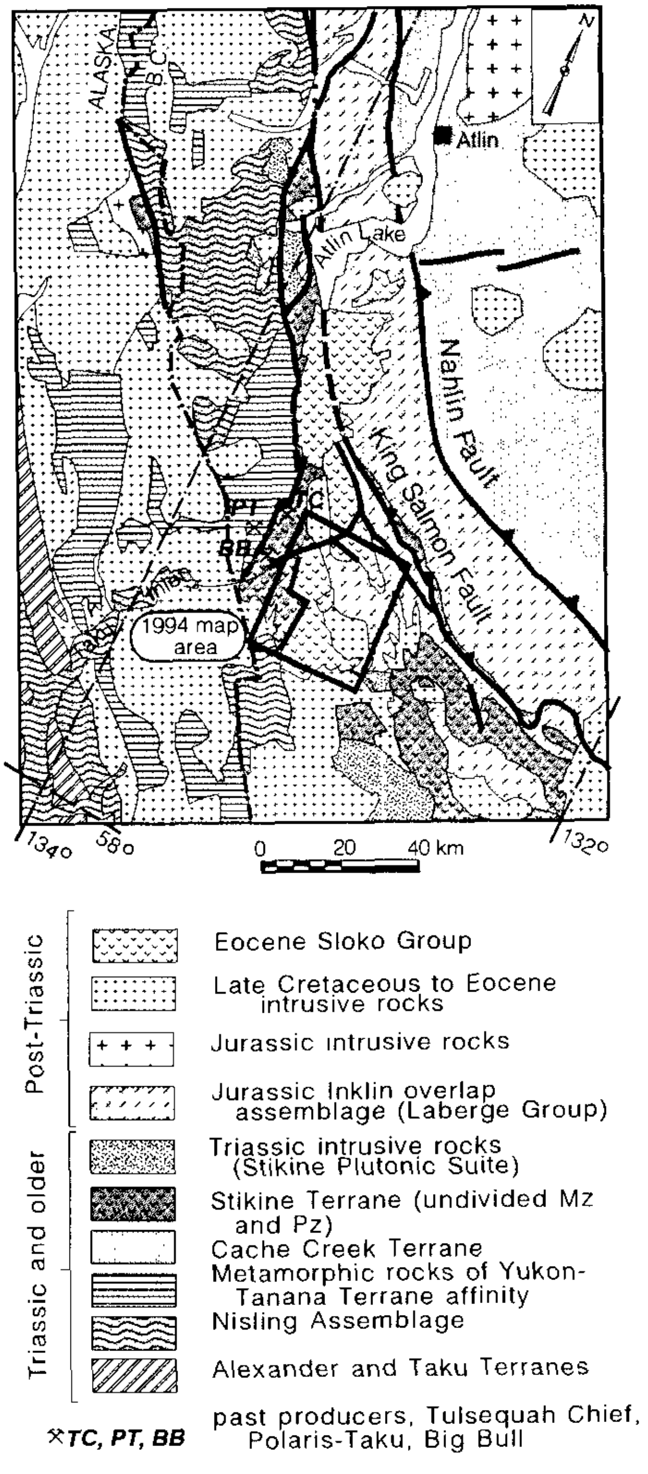

Figure 2. Simplified geologic map of the Atlin and Tulsequah area after Wheeler and McFeely (1991), Monger (1980), Mihalynuk and Rouse (1988) and Mihalynuk *et al.* (1989, 1990, 1994b), showing major faults and lithotectonic elements. The Tulsequah map area straddles parts of the Jurassic Inklin overlap assemblage, Stikine Terrane, and metamorphic rocks of mixed arc and siliciclastic affinity and uncertain (possibly Yukon-Tanana) terrane assignment.

sedimentary rocks of Stikine Terrane, and overlying Late Triassic to Middle Jurassic arc-derived strata of the Whitehorse Trough (including the Inklin overlap assemblage of Wheeler *et al.*, 1991). Mesozoic rocks of the Stuhini Creek map area are dominated by arc-flanking strata of the Whitehorse Trough: parts of the Upper Triassic Stuhini Group and the Lower to Middle Jurassic Laberge Group. These are overlain by Tertiary continental arc volcanic rocks of the Sloko Group which are intruded by partly comagmatic Coast plutons. The Stikine assemblage is restricted mainly to the south and western margins of the map area, but probably extends beneath much of the Mesozoic and Tertiary cover. On the northern and southern edges of the map area, the geology is influenced by two major crustal structures. Eastern splays of the transcurrent Llewellyn fault system juxtapose ductilely deformed Paleozoic rocks with Mesozoic rocks between Sittakanay River and Stuhini Creek. To the north, southwest-verging frontal thrusts of the King Salmon fault system interleave Jurassic and Triassic Whitehorse Trough strata Second order normal, or high-angle reverse faults, juxtapose Tertiary volcanics with Mesozoic and Paleozoic rocks. Deformation generally increases in intensity with age.

Relicts of a past continental glaciation are everywhere in evidence. Glacially carved U-shaped valleys have been modified little since retreat of expansive ice sheets. Remnants of this ice persist as alpine glaciers which produce a rich array of glaciomorphic features and glaciofluvial deposits.

STRATIGRAPHY

Excellent exposure, lack of widespread ductile deformation, and good fossil age control make for relatively clear-cut lithological relations in marine sedimentary strata. However, several volcanic lithologies belonging to different major rock suites are strikingly similar. Without solid age data, discrimination between such lithologic divisions (even Tertiary versus Paleozoic) is not without ambiguity. For example, similarity of Paleozoic and Triassic augite-phyric breccias, flows and tuffs has historically caused correlation problems. We outline lithologic criteria which can be used to help distinguish between these look-alikes (Table 1). Rare earth element analyses currently in progress will hopefully point to a less subjective method of descriminating between the two.

More than 30 new macrofossil collections greatly increase the available fossil age data for the area A further 15 samples were collected for microfossil extraction; results are pending. All macrofossil and most microfossil samples are from Mesozoic strata, placing good constraints on stratigraphy of this age. Two Paleozoic samples were collected in 1993 from just off the western edge of the Stuhini Creek map sheet. They yielded Late Carboniferous (Moscovian) fusulinaceans (Rui, 1994; C-208180) and Late Carboniferous to Early Permian conodonts (Orchard, 1994; C-208199), establishing with certainty that the Paleozoic Stikine assemblage extends to south of the Taku River.

PALEOZOIC

Paleozoic Stikine assemblage strata crop out along the western margin of the map area on both sides of the Taku River (Figure 3). North of the river they can be traced from the west side of Mount Metzgar (104K/12) where mapped in 1993. Rocks south of the Taku River, on Sittikanay Mountain, can also be confidently correlated with the Stikine assemblage, but unlike well preserved, correlative strata to the north, polyphase deformation, indistinct lithologies, and precipitous terrain prevent extensive subdivision of these rocks. Mount Erickson lies midway between these two areas. It is largely underlain by rocks that are tentatively correlated with the Stikine assemblage. A tenuous correlation is also made with metamorphosed rocks in the southeast corner of the map area, in the Sutlahine River valley.

Rocks at Mount Metzgar can be correlated on a unit by unit basis with well defined Pennsylvanian to Permian Stikine assemblage rocks of the Mount Eaton block (Mihalynuk *et al.*, 1994a, b). Although distinctive, many units are too thin to be represented on a 1:50 000-scale map, and are, of necessity, grouped with the dominant lithology. They are probably correlative with one of two broad packages recognized south of the Taku: a structurally higher, heterolithic, well layered upper package that contains distinct, mappable units and conspicuous white-weathering carbonate. It contrasts with a structurally lower package dominated by indistinct mafic volcanics and fine-grained sediments with minor impure carbonate. Correlation of the lower package is

TABLE 1. CRITERIA FOR DISTINGUISHING STIKINE ASSEMBLAGE AND STUHINI GROUP PYROXENE PORPHYRY UNITS.

Criteria	*Stuhini Group pyroxene-phyric*	*Stikine assemblage pyroxene-phyric*
weathering	olive green to orange brown	grey green to dark green
other lithologies	typically monomict, minor carbonate clasts, others rare	variable: feldspar porphyry, carbonate clasts, rare dacite
matrix	commonly calcareous	may be calcareous
metamorphism	variable, typically lower greenschist	greenschist, hornfelsed to higher grade
fabric	folded, but not schistose	phyllitic zones common, at least two phases of deformation well displayed

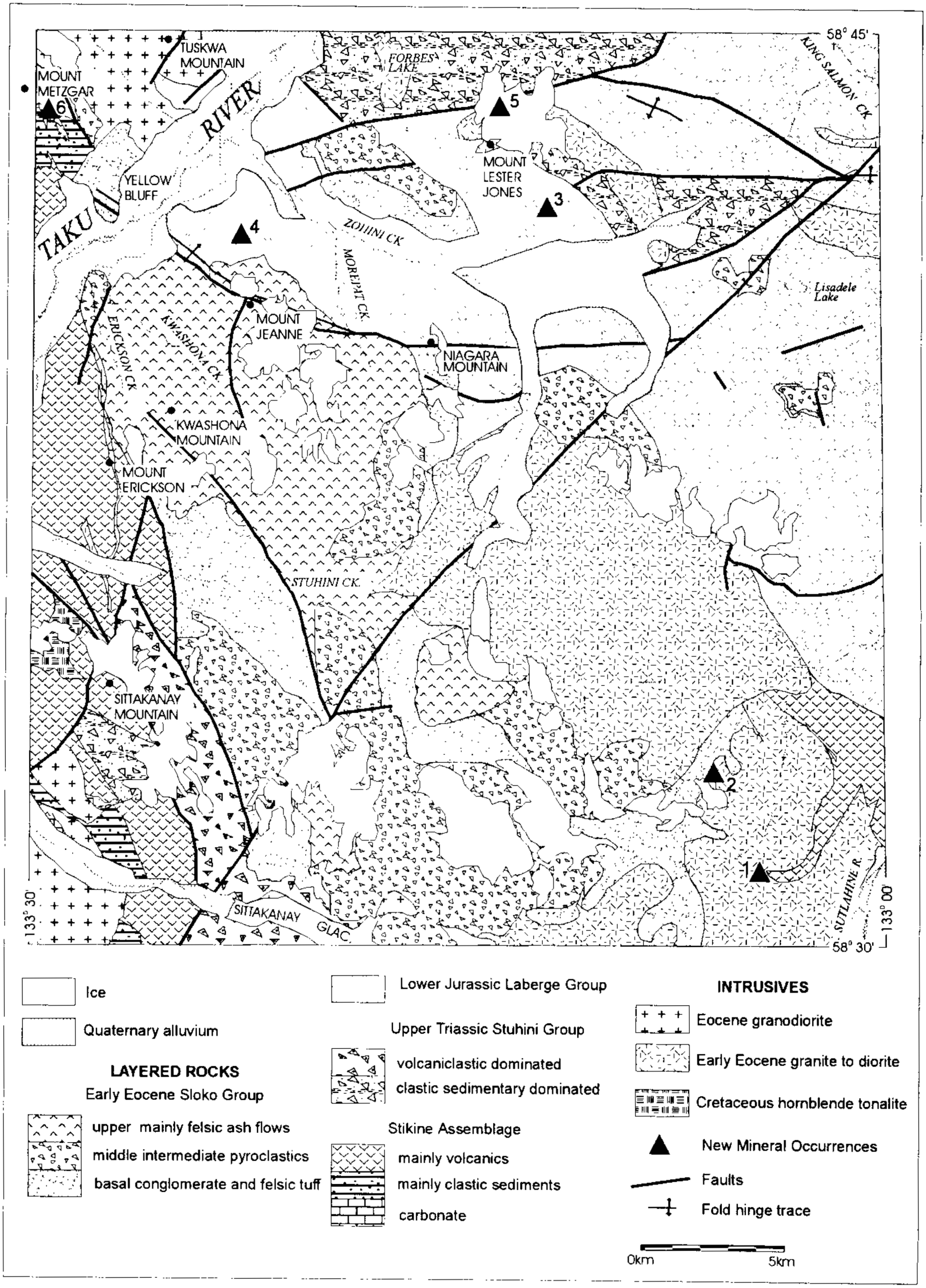

Figure 3. Generalized geology of the Stuhini Creek mapsheet.

less certain, but it most closely resembles Mississippian to Pennsylvanian rocks of the Mount Eaton block.

MOUNT METZGAR

A wide variety of arc lithologies crop out along the eastern cirque of Mount Metzgar. From north to south these include: maroon and green, fine-grained lapilli ash tuff; well bedded, tan bioclastic limestone; bedded to massive chert; sulphidic, calcareous, rusty, black, well bedded argillite and siltsone; decimetre-thick interbeds of limestone and chert; bright green, chlorite and calcite amygdaloidal, monomict andesite tuff; light grey, stretched limestone-cobble debris flow; purple to green, pyroxene-phyric pillow breccia with a calcareous matrix; dark green, flattened, lapilli tuff of probable basaltic andesite composition; and centimetre to decimetre interbeds of argillite and cherty, tuffaceous siltstone. The last few units apparently change along strike down-slope into dark brown and green, fine-grained tuffaceous sediments and sparse lapilli tuffite, that form locally developed, albeit inconspicuous, centimetre to decimetre-thick beds. More commonly these form disrupted beds with metre-scale close to isoclinal folds. Matrix compositions are typically siliceous, with carbonate locally predominating. Hornfelsing is common, possibly due to plutonic rocks in the near subsurface.

Structural disruption is clearly evident, but no duplication of stratigraphy was identified. Well developed shear zones undoubtedly result in juxtaposition of originally disparate units, but their involvement in drastic down-slope lithologic change is uncertain. Perhaps a severe facies change is preserved on these lower slopes of Mount Metzgar. Similar examples of southeastward fining are seen downstream along this side of the Taku River.

Rhyolite is reported from this area (Sorbara, 1983), but none was observed during our field investigation. Farther west along the southern ridge of Mount Metzgar, dark green volcanic breccia and bedded tuff predominate, as indicated by landslide debris on the slopes below.

MOUNT SITTIKANAY (AND SOUTH)

In general, ductile deformation increases in intensity while confidence in correlation decreases both northeast and southwest of Mount Sittikanay. Northeast of Mount Sittikanay, in the Stuhini Creek valley, dynamothermally metamorphosed phyllite and schist are cut by discrete shear bands within the Sittikanay shear zone (see 'Structure' below). To the southwest, extensive intrusion by Coast Belt plutons caused widespread thermal metamorphism. Primary sedimentary component decreases to the northeast where a lower succession of massive volcanic strata is dominant. Protolith textures are best preserved in a belt of distinctive units that extend south into the Sittikanay River valley. Mapping within this belt has focused mainly on the westernmost map margin, on Mount Sittikanay. The belt is outlined by conspicuous white-weathering carbonate layers, two of which yield Late Carboniferous microfossil ages (see previous section). Some distinctive individual units can be correlated with those in the Tulsequah River area, where unit designations are those of Mihalynuk *et al.* (1994b).

An **interbedded chert and phyllitic argillite and minor bioclastic carbonate** unit is probably equivalent to the tuffaceous mudstone greywacke unit (MPEst). It is white weathering with beds 2 to 30 centimetres thick. Unlike unit MPEst, thin bioclastic carbonate units are not common throughout, but occur only at the structural top of the unit. It may be a deeper water equivalent of typical unit MPEst. **Pyroxene porphyritic breccia and maroon lapilli tuff** are affected by tight folding, but otherwise are identical to units PEvt and MPEva. Massive white chert in layers up to several metres thick and grey, phyllitic argillite and grey-green, fine-grained cherty basalt lack distinctive features which permit correlation. A thick section of intermixed siliceous argillite and fine-grained to locally medium-grained and holocrystalline, green basalt tuff or flow and sill layers up to 10 metres thick sits structurally below the carbonate belt. These intermixed rocks are suitable protoliths for muscovite and actinolite phyllite and schist that occur low in both the Sittikanay River, Stuhini Creek and Taku River valleys.

MOUNT ERICKSON

The peak and southern flanks of Mount Erickson are underlain by dark green to black, fine to medium-grained, basaltic pyroxene±feldspar porphyry breccia, lesser flows and intrusive equivalents. Epidote-chlorite alteration of matrix and along fractures is pervasive, but is less intense in pyroxene phenocrysts that comprise 10% to rarely 50% of the rock. Hypabyssal gabbroic intrusions are believed to be comagmatic with volcanic strata. Both are cut by veins of epidote, hornblende and potassium feldspar.

Sediments and fine-grained basalt dominate the northern slopes of Mount Erickson, together with fine-grained, black basalt flows with relict pillow features. Included in the sedimentary package are hornfelsed dark green and purplish cherty siltstone and conspicuous, contorted white and black banded carbonate and massive white marble layers, 6 metres or more thick. Hornfelsed siltstone is commonly interbedded with green to pink, laminated carbonate, at one locality containing basaltic 'clasts' up to 40 centimetres in diameter. Pervasive thermal alteration of these rocks has produced widespread silicification, development of fine-grained biotite(?), and formation of epidote-actinolite-chlorite-quartz veins and knots. Grossularite occurs in isolated pockets. These sediments are similar to those exposed low on the eastern slopes of Mount Metzgar (see above).

SUTLAHINE RIVER

Immediately west of the Sutlahine River, a screen dominated by foliated, mafic volcanic rocks is migmatitic where in contact with enclosing granite of probable Eocene age. Relict pillows and well bedded, highly indurated tuffaceous sediments are preserved in rare instances. Calcsilicate pods within foliated metabasalt are interpreted to be interpillow micrite remnants. These pillow basalts are important because they host disseminated blebs and veins of chalcopyrite (see "Oksarah" below)

Correlation of these rocks is based upon: lithologic similarity with Paleozoic rocks, particularly the sediment-dominated unit at Mount Erickson, and proximity and continuity of units at this locality with another series of Paleozoic exposures just east of the Sutlahine River (Souther, 1971). Furthermore, several hundred square metres of Laberge conglomerate apparently rests on the probable Paleozoic rocks, but they are not ductilely deformed, thereby placing a minimum age limit on deformation of the underlying rocks.

TRIASSIC: THE PYROXENE PORPHYRY PROBLEM

Discrimination between Paleozoic and Triassic strata remains problematic, even two full decades after publication of Souther's 1:250 000-scale map of the Tulsequah area, and with considerably more isotopic and paleontologic data at our disposal. This is particularly true for crowded augite-porphyritic volcanic rocks which are now known to be relatively widespread in the upper Paleozoic Stikine assemblage (Bradford and Brown, 1993; Gunning, 1993; Mihalynuk *et al.*, 1994a, b; J.M. Logan, personal communication, 1994), but which are generally considered a hallmark of the Upper Triassic Stuhini Group. Similar ambiguities exist for the feldspar-porphyry-dominated lithologies of the Eocene Sloko Group.

In the Tulsequah River map area (104K/12), crowded coarse pyroxene porphyritic breccia (pyroxene up to 2 cm), flow units and pyroxene crystal tuff are well dated as middle Pennsylvanian and older on the basis of associated fossiliferous strata. Pyroxene porphyry blocks within fossiliferous tuffaceous limestone containing fusulinids provide a minimum Moscovian age (middle Pennsylvanian; Rui, 1994). Pyroxene porphyry flows incorporate sediment and are backveined by penecontemporaneous dikes. They underlie a carbonate debris flow unit that contains Wolfcampian to Sakmarian fusulinids (late Pennsylvanian - early Permian; Rui, 1994). Slightly higher in the section, blocks of pyroxene crystal tuff occur in a debris flow with a fossiliferous rudstone matrix. All of these occurrences are interpreted to stratigraphically overlie up to 1500 metres of pyroxene porphyry dominated breccia, which in turn overlies early Mississippian rhyolite (Sherlock *et al.*, 1994) and sediment (Mihalynuk *et al.*, 1994b). These pyroxene porphyry breccias and flows bear close resemblance to Upper Triassic augite porphyry of the Stuhini Group, and in both field and microscopic examination, may be visually indistinguishable. Some criteria that may collectively aid in discrimination between the two suites are listed in Table 1, but singularly these criteria are of limited use.

A thick, intermediate to rhyolitic succession was mapped by Souther (1971) as part of the Stuhini Group. Although not characteristic, such felsic Stuhini Group units are dated in the Iskut River area where Anderson (1989) includes them with a distinct, western felsic facies.

In the Stuhini Creek area, we exclude felsic rocks from the Stuhini Group for several reasons.

- Just above the Sittikanay Glacier terminus, a well exposed, polymictic basal conglomerate rests on an incised paleosurface above steeply dipping, crowded augite porphyries believed to be Stuhini Group (Photo 1). This conglomerate grades upwards into volcanic strata of the felsic unit.
- Clastic and felsic volcanic strata can be traced from Niagara Mountain, where they overlie the Laberge Group (a relationship previously mapped by Souther, 1971), across Morepat Creek, into an area previously

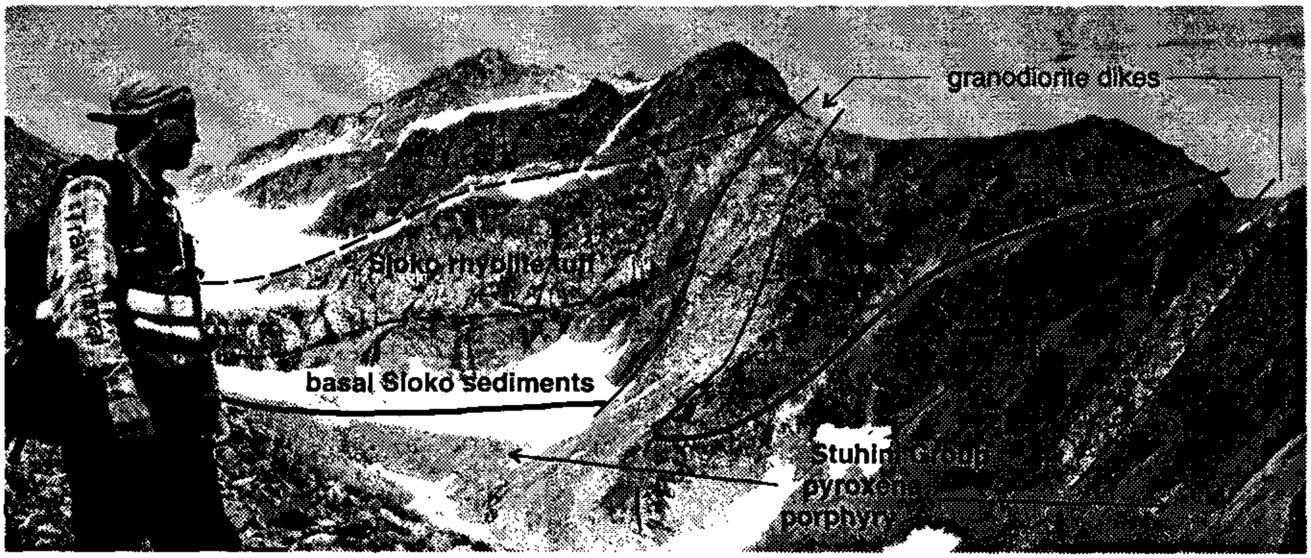

Photo 1. Steeply bedded augite porphyry, probably Stuhini Group (uTS), is unconformably overlain by gently dipping polymictic conglomerate, rhyolite and variegated breccia, interpreted to be Sloko Group (eES). Both units are later cut by granodiorite dikes (eTg) 10 to 50 metres thick.

mapped as Stuhini Group.

- *Some lithologies within the felsic volcanics are identical to units clearly within the Sloko Group outside the map area.*
- Drag folds across a major normal fault at Mount Jeane are consistent with upward motion of Laberge strata with respect to the adjacent felsic volcanic strata (Photo 2).
- Pyroclastic dikes, believed to be subvolcanic feeders to volcanic rocks at Mount Jeane, clearly cut Laberge strata.

Two major belts of Stuhini Group are present in the map area (Figure 4). A southwest belt is dominated by primary volcanic strata and detritus derived almost exclusively from this source. It is apparently fault bounded, except where in contact with unconformably overlying Sloko Group. A northeast belt is dominated by conglomerate sheets within fine-grained clastics; volcanic flows are uncommon.

Photo 2. Laberge strata are drag folded along a high-angle normal fault that juxtaposes them with Sloko Group strata on the west face of Mount Jeane. Over 2 kilometres of vertical displacement has occurred. About 1.4 kilometres of relief is shown in the photo. Low-angle fault cutoffs are seen in the cliff face (see arrow to left of shadow).

SOUTHWEST BELT

A thick monomict section of crowded pyroxene porphyry breccia and derived sandstone crops out in a belt 1 to 3 kilometres wide and broadening to the southeast, that extends from lower Stuhini Creek to the toe of Sittikanay glacier. These rocks are lithologically identical to Stuhini Group in the Tagish area to the north where there is good fossil age control (*e.g.*, Mihalynuk and Mountjoy, 1990). It is olive brown to olive green, with coarse, dark green, euhedral pyroxene commonly comprising more than 25% of the rock. Pyroxene weathers positively on slightly weathered surfaces and negatively on deeply weathered surfaces. Zones of abnormally high calcite content commonly weather orange, especially where fractures are abundant. Breccias are massive, but fine-grained clastics may display *delicate ripple cross-stratification, grading, scouring and*

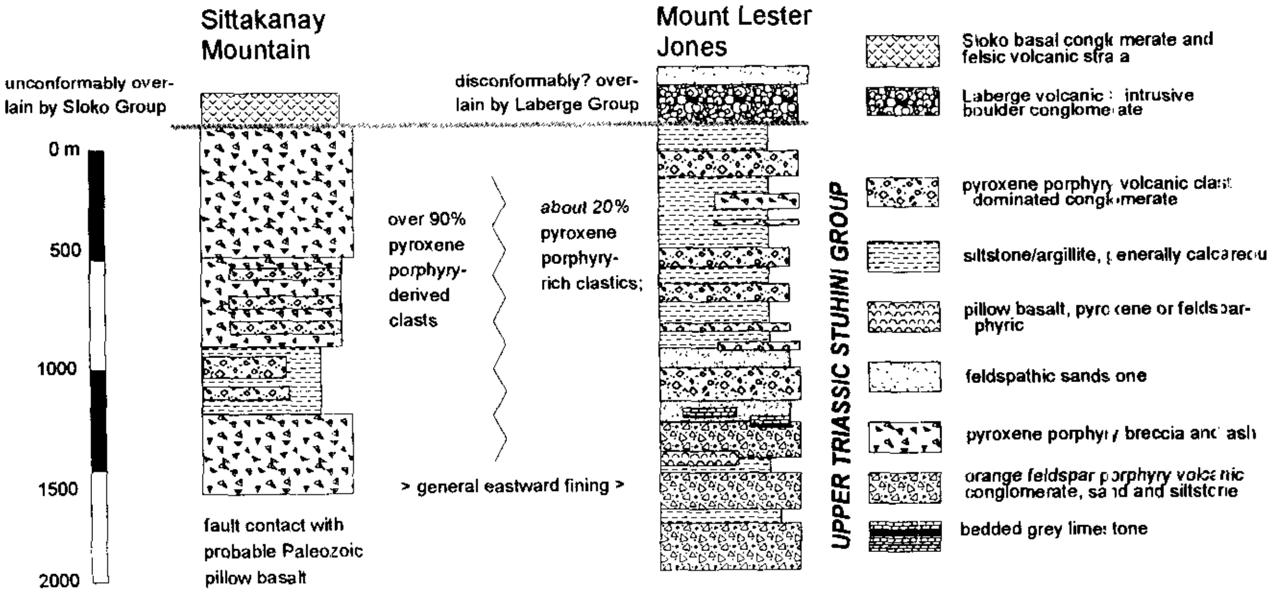

Figure 4. Stylized stratigraphy of the Upper Triassic Stuhini Group.

load structures.

Only two units within the southwestern belt show derivation from sources not completely overwhelmed by the pyroxene-porphyry component. A well bedded conglomerate contains round clasts of pyroxene porphyry, tabular feldspar porphyry and sparse carbonate. It has a calcareous sandstone matrix. Contorted, tan and black, centimetre to decimetre-scale silt-argillite couplets occur at one interval. They show evidence of soft-sediment deformation and are riddled with minor faults having apparent offsets of 10 centimetres or less.

Folding within this belt of Stuhini rocks is intense. It is difficult to recognize in massive breccia units, but can be clearly seen in the derived clastics where open to close folds are common. Brittle faults follow two dominant trends: northwest and west.

NORTHEAST BELT

Two lithologies comprise most of the northeastern belt: conspicuous lobes and sheets of pyroxene porphyry and carbonate cobble and boulder debris flows (Photo 3), and enveloping dark brown to black calcareous siltstone and argillite. The argillite contains ammonites, halobiid bivalves and belemnites. Locally it contains massive, fine-grained lenses of pyrite up to several metres long and a few centimetres thick - probably of biogenic origin, resulting from deposition in a primarily euxinic environment. Composite sheets and lenses of conglomerate are 90% derived from pyroxene-porphyry breccia, tuff and tuffite: lithologies that are common in the southwestern belt. Carbonate boulders up to 0.5 metre in diameter comprise about 10% of the clasts on average. Individual conglomerate beds can be mapped intermittently along strike for distances of more than 2 kilometres and some may be more than 250 metres thick. One distinctive conglomerate unit also contains up to 30% grey 'chert' clasts. Some of these clasts contain sparse blades of plagioclase, obviously derived from a mainly aphanitic volcanic unit.

Structurally below the conglomerate-argillite unit is a monomict, orange-weathering, tabular (2-3 mm, subhedral to euhedral) feldspar porphyry cobble conglomerate (and tuffite?) with khaki interbeds of feldspathic sandstone and siltstone. It is more than 300 metres thick and is regionally extensive. Overlying it, in apparent stratigraphic continuity, is a mixed succession of feldspathic sandstone; disrupted carbonate beds up to 10 metres thick, but typically less than a metre thick; pyroxene crystal tuff and heterolithic debris flows. North of the map area, near Sinwa Mountain, this unit grades into carbonate framework reefs .

Nowhere within the map area can Stuhini Group rocks be unequivocally shown to rest on Paleozoic Stikine assemblage strata. The upper contact with the Laberge Group, on the other hand, is apparently exposed on the southeast flank of Mount Lester Jones (Photo 4), and is probably disconformable as previously suggested by Monger (1980). At this locality a heterolithic conglomerate containing a large proportion of clasts of Stuhini feldspar-porphyry conglomerate, cuts down into the calcareous argillite and interbedded pyroxene-porphyry and carbonate-cobble conglomerate. However, the interval in which this contact occurs is poorly dated. At most other localities a structural contact is displayed.

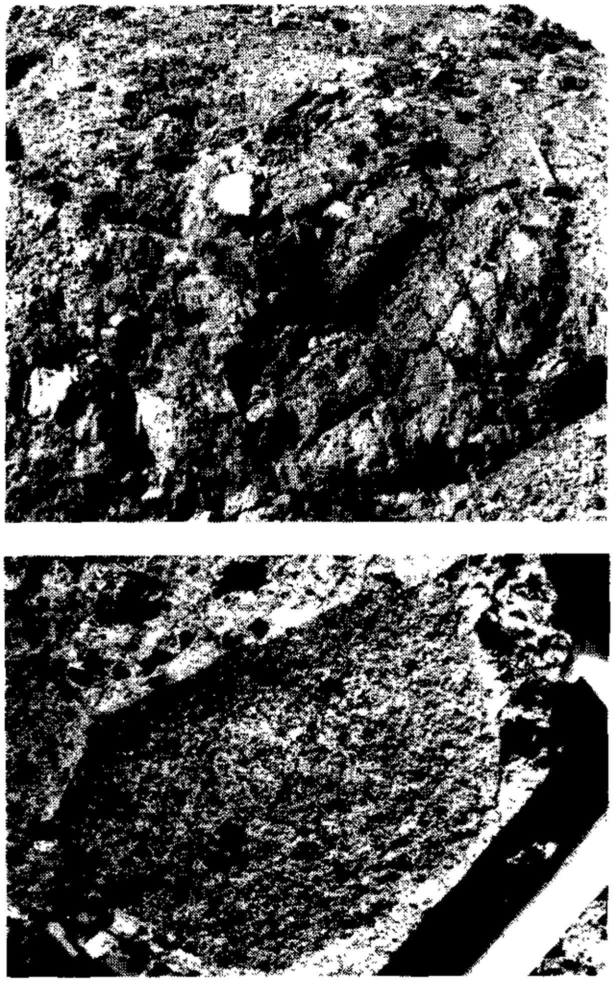

Photo 3. Coarse Stuhini Group conglomerate is dominated by boulders of pyroxene porphyry and lesser white-weathering carbonate. (b) A boulder of crowded euhedral-pyroxene porphyry.

Although direct correlations cannot be made, it appears that coarse conglomerates of the northern Stuhini belt were derived from the southwest (or similar) volcanic belt, consistent with the observations of Monger (1980). Sparse paleoflow measurements from both belts indicate northerly paleoflow, supporting this contention.

JURASSIC

A large part of the northeast quadrant of the map area is underlain by a succession of volcanic and intrusive clast dominated conglomerates, sandstone, feldspathic wacke, siltstone, minor metamorphic clast rich and chert-pebble conglomerate and rare tuffite of the Laberge Group. With the exception of metamorphic-clast rich conglomerate and chert-pebble conglomerate, constituent lithologies are quite similar to those found in the Atlin Lake area (Bultman, 1979; Mihalynuk *et al.*, 1989; Johannson, 1993).

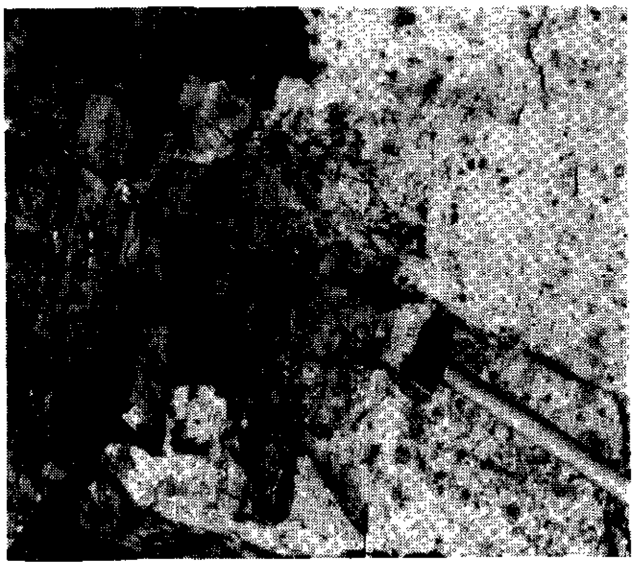

Photo 4. Polymictic volcanic conglomerate cuts down into Upper Triassic argillite on the east flank of Mount Lester Jones.

Fossil ammonites are abundant. Numerous collections from the area should provide good age control on the Laberge strata. Faunal constraints indicate a sub-boreal to boreal paleobiogeography. Other fossils, notably bivalves, gastropods and ichnofossils locally occur in profusion.

Accumulations of Laberge strata may reach 3000 metres. Southeast of Lisadele Lake, intrusive and volcanic-clast conglomerate alone, attain a thickness in excess of 1000 metres. However, structural complexities make estimates of true thickness difficult, especially in the absence of pending fossil age control. Laberge strata record depositional settings that span lower shoreface through basin plain environments. Much of the succession represents shallow-marine deposition and sedimentological observations suggest a prograding fan delta setting with distal equivalents.

CONGLOMERATE

Distinctive clast populations permit subdivision of conglomerate into several mappable units. There is a general up section progression from Pliensbachian volcanic to Toarcian intrusive clast dominated conglomerate (Figure 5). A distinct interval of metamorphic clast rich intrusive conglomerate occurs in the middle to upper Toarcian. Chert-granule to pebble conglomerte occurs near the top of the Laberge succession, in the Lower Bajocian.

Clasts typically have high sphericity, are well rounded and range from granules to coarse boulders (up to 2 m diameter) with cobbles most abundant (except chert-clast granule conglomerate). Individual bed thickness ranges from around one metre to several hundreds of metres. Bed thicknesses in the 1 to 10-metre range are most common. Beds commonly have scoured

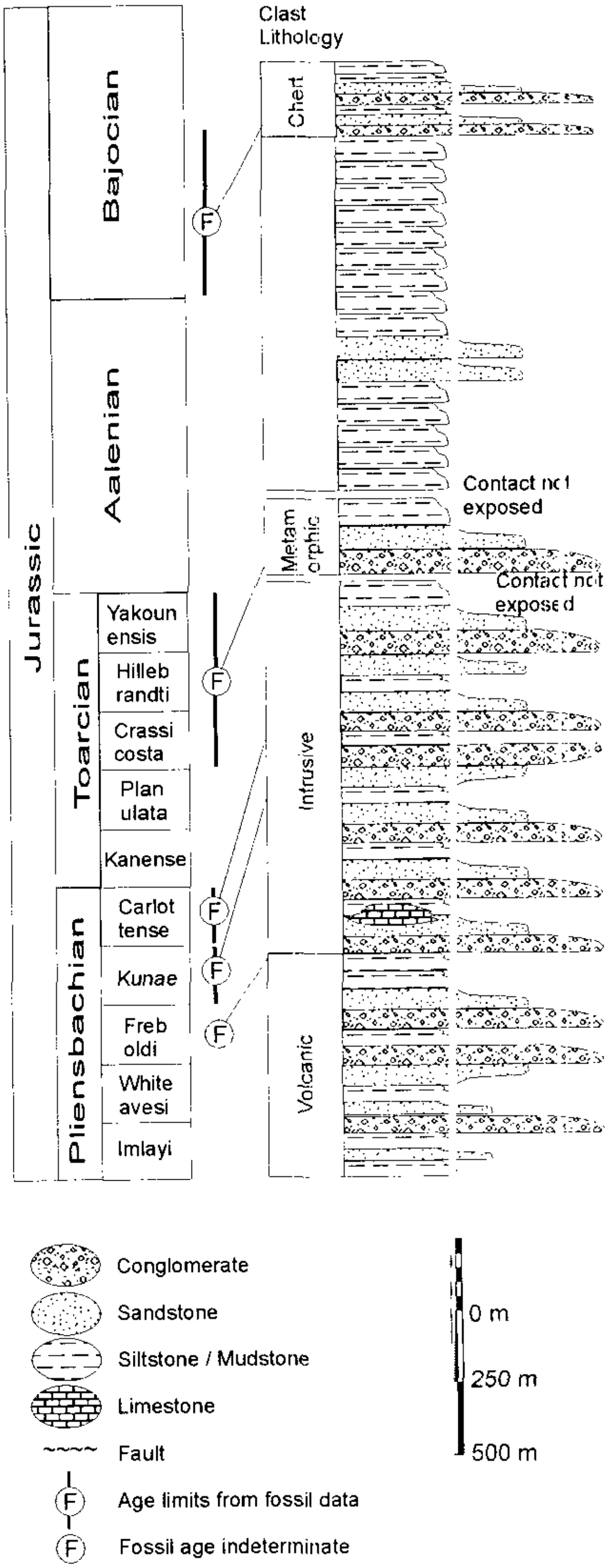

Figure 5. Indirectly measured sections representing lithologic variability of the Lower Jurassic Laberge Group within the map area.

bases and normal grading; however, reverse grading occurs locally. Individual conglomerate layers can be surprisingly continuous. One conglomerate sequence is mapped intermittently for over 7 kilometres.

Conglomerates are invariably mixtures of different clast types. Mixtures of intrusive, volcanic and lesser sedimentary intraclasts comprise the lower conglomerate units. **Intrusive** clast lithologies include: leucocratic quartz monzonite, monzonite, granodiorite, quartz monzodiorite, granite and monzogranite. A common clast lithology is potassium feldspar megacrysts in a holocrystalline pink hornblende-biotite granodioritic groundmass. It is less commonly foliated, and rarely displays a fine-grained, dark grey groundmass enclosing bladed plagioclase phenocrysts, and is invariably epidotized. Unusual but conspicuous alaskitic clasts are cut by dense sets of hairline fractures with black coatings. **Volcanic** clast lithologies include: phyric to aphanitic intermediate to felsic volcanics, trachytic fine hornblende -phyric green and maroon andesites, green to brown coarsely bladed feldspar porphyry, and lithic crystal ash to lapilli tuffs. They are dominated by tan to grey or green-weathering feldspar porphyries. Feldspars are dominantly plagioclase ranging in size from 2 millimetres to 2 centimetres and comprising 5% to 40% of the clast. Distinctive dark green-weathering, crowded pyroxene porphyry clasts are locally predominant. **Metamorphic** clasts are generally white-weathering, leucocratic, quartz-rich feldspathic mica schist and mylonite (Photo 5a). Compostions of quartz-rich schist clasts range from feldspathic quartz-mica schist to quartzite, both non-carbonaceous and carbonaceous and strongly foliated to gneissic. Metamorphic vein-quartz is also common. Possible provenance affinities include the Yukon-Tanana Terrane and metamorphosed Stikine assemblage. **Chert** pebbles and granules are buff, black to white and less commonly red in colour (Photo 5b); some with visible radiolarians. Many cherty clasts are derived from rhyolite as indicated by the presence of feldspar and quartz microlites in thin section. Chert conglomerate beds display good normal grading, are several decimetres thick or occur in sets up to several metres thick. They are very well sorted, well rounded, and monomict in nature, with cherty clasts comprising at least 95% of the rock. Although relatively thin, they are very distinctive and appear to be continuous over large distances, and thus show great promise as stratigraphic marker horizons. They occur at the highest stratigraphic levels, and are believed to be Aalenian to Bajocian (lower Middle Jurassic) in age.

SANDSTONE, SILTSTONE, MUDSTONE

Massive, thick-bedded, green, coarse-grained arkosic wacke is the dominant lithology in the Atlin area, but is subordinate to conglomerate and fine-grained clastics in the Stuhini Creek area. Spherical calcareous concretions are relatively common and somewhat diagnostic of these sandstones. A very distinctive light-weathering, porous and permeable tuffaceous litharenite crops out in the Lisadele Lake area. It is similar to units on Atlin Lake

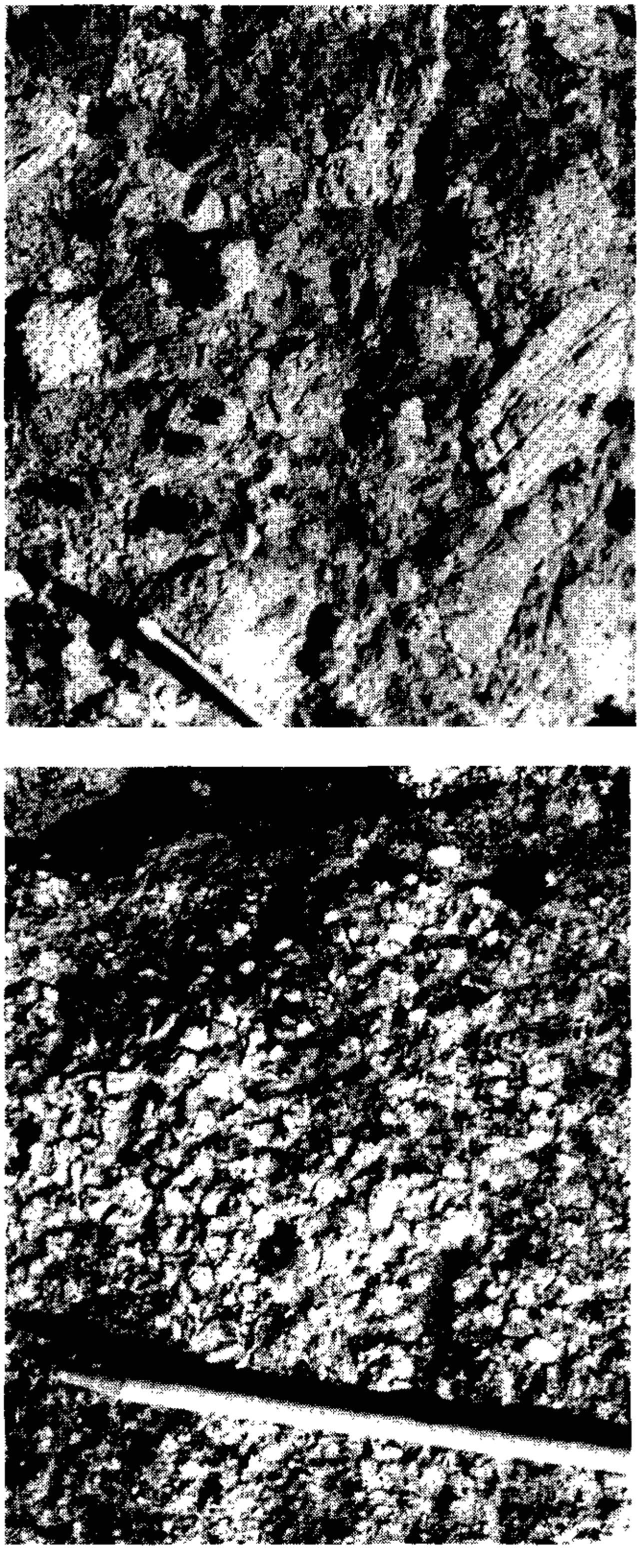

Photo 5a. Laberge Group metamorphic clast rich conglomerate at the conglomerate-argillite transition. (b) Chert granule to pebble conglomerate in the upper shale-dominated Laberge Group lithologies.

correlated with the *circa* 185 Ma Nordenskold dacite (Johannson, 1993; preliminary GSB age data).

Siltstone and mudstone generally occur as thin-bedded silt-argillite couplets and laminae and fine sand-mud couplets that commonly display the partial Bouma sequences T_{ce}, T_{de} and T_{bcde}. These rocks are normally moderately well indurated, but a distinctive, fossiliferous mudstone along King Salmon Creek is so poorly indurated that minor abrasion on a wet surface returns the rock to mud. Depositional environments include both shallow-marine and deep-marine fan-fringe to basin plain settings.

LIMESTONE

Bioclastic and biogenic limestone units include rudstones and patch reefs. Rudstones appear to be laterally extensive as the same lithology occurs at similar stratigraphic intervals where it is mapped intermittently across the northern part of the map area. Less useful markers are the bioherms which pinch out over distances of tens to hundreds of metres. One rudstone is a bivalve hash 2 to 3 metres thick, blue-grey to black-weathering and comprised of up to 80% fossil fragments, mostly bivalve material with a minor gastropod component. Some bivalve fossils are preserved in the growth position (Photo 6). A more extensive, rusty buff weathering rudstone horizon, several metres thick is composed almost exclusively of gastropods.

A bioherm of probable Pliensbachian age occurs low within the volcanic clast dominated succession near Lisadele Lake. It is over 8 metres thick and light grey except for local maroon discoloration associated with minor faults.

TERTIARY SLOKO GROUP

Geological mapping in 1994 indicates that Sloko Group lithologies are much more extensive than previously thought. Most of the rocks around Yellow Bluff, Kwashona Creek and Stuhini Creek are here included in the Sloko Group. Unlike 'typical' Sloko volcanics to the north, these strata are steeply dipping, and locally are folded.

Sloko Group volcanics are bimodal, but dominated by felsic lithologies. They rest unconformably upon a high-relief paleosurface that was etched into Mesozoic and Paleozoic strata. Voluminous air-fall units are regionally mappable, but the distribution of flow and epiclastic units is profoundly affected by paleotopography and synvolcanic faulting. These units occur as more isolated and sporadic units.

Photo 6. Robust bivalves in arkosic biomicrudite are locally in the growth position.

Due to rapid facies changes within the Sloko volcanics, not all units comprising the Sloko Group in the Tulsequah area (Mihalynuk *et al*, 1994b) occur within the Stuhini Creek map area. Previous regional mapping outlined six different mappable units including: a basal conglomerate; massive, well indurated, black pyroclastics (Opposer formation); massive, tan-weathering breccias (Mount Haney formation); interlayered feldspar-phyric flows and volcaniclastics (Nakonake formation); rhyolite domes and tuffs; and trachyte flow succession(s) In the Stuhini Creek area, several additional units are required to describe the Sloko

TABLE 2. CRITERIA FOR DISTINGUISHING SLOKO GROUP BASAL CLASTICS FROM LABERGE GROUP STRATA.

Criteria	*Sloko Group sediments*	*Laberge Group*
induration	poor	moderate to strong
matrix (both are feldspathic)	grey tuffaceous	green wacke
fracture	fractures around clasts (variable)	commonly fractures through clasts
weathering	grey (mainly non-calcareous)	orange (carbonate matrix common)
common clasts	Laberge clasts most common	Intrusive, volcanic, pyroxene-phyric
Laberge clasts	*rounded (except paleo-colluvium)*	*angular intraformational ripups*

Group. Two of these units are sufficiently persistent to warrant informal formation designation: coarse sandstone and Laberge Group clast rich conglomerate and siltstone (Niagara formation); and vitrophyric tuff containing fragments of feldspar crystals, pumice, coarse ash and fine lapilli (Teepee formation). Other units include: thick, bleached and silicified, indurated, feldspar-phyric flows and lesser interflow breccia and tuff; green hornblende and feldspar-phyric breccias; chaotic intermediate to felsic feldspar-phyric lapilli tuff to breccia; well bedded fine tuff or tuffite; and biotite and sanidine-phyric breccias.

NIAGARA FORMATION (INFORMAL)

Well bedded, black, white, tan and rust-weathering conglomerate, siltstone, epiclastics, tuff and tuffite are deposited in grabens atop the Laberge Group. Bedding is several centimetres to tens of metres thick. Thickness generally increases with the proportion of primary volcanic material. Black layers are carbon rich. Fossil swamp grasses, palm logs and palm fronds are common in siltstone and conglomerate (Photo 7a). Interbedded tuff is mainly pumice rich, feldspar±quartz-phyric and probably of dacitic composition. In the absence of associated tuffs, dominantly sedimentary Sloko strata are difficult to distinguish from Laberge rocks. Some distinguishing criteria that may be helpful are listed in Table 2.

TEEPEE FORMATION (INFORMAL)

Dark brown to tan-weathering vitrophyric tuff is a resistant, peak-forming unit. It caps Kwashona Mountain and several of the high, craggy peaks southwest of Morepat Creek. Coarse columnar jointing is common. Lithic lapilli (up to 15%) and angular feldspar fragments (up to 20%) float in a densely welded black matrix of vitric lapilli and ash (Photo 7b and 7c).

This unit is widespread within the map area, and may be typical of a series of regional eruptive units. For example, an identical unit caps ridges at Teepee Peak, about 120 kilometres to the north, near the Yukon border.

FELDSPAR-PHYRIC FLOWS

Thick, monotonous plagioclase-phyric flows and minor interflow breccia and tuff constitute this unit. The flows are dark blue-grey to black or green and well indurated. They contain 5 to 30% subhedral plagioclase phenocrysts, generally less than 0.5 centimetre long, in a glassy to very fine grained groundmass. These units typically weather a medium to dark grey and are massive, however, individual flows may be visible when viewed from a distance. Some flows are pyritic, and weather to an orange-brown gossanous surface.

Interflow or interlayered breccias are generally the same colour and composition as the flows. They contain plagioclase-phyric fragments in a finer-grained, plagioclase-phyric groundmass. The plagioclase phenocrysts in the fragments are larger than those in the groundmass, and the fragments may be 0.5 metre or larger in long dimension. Tuffs within this sequence contain variable amounts of fragments which are almost exclusively of volcanic origin.

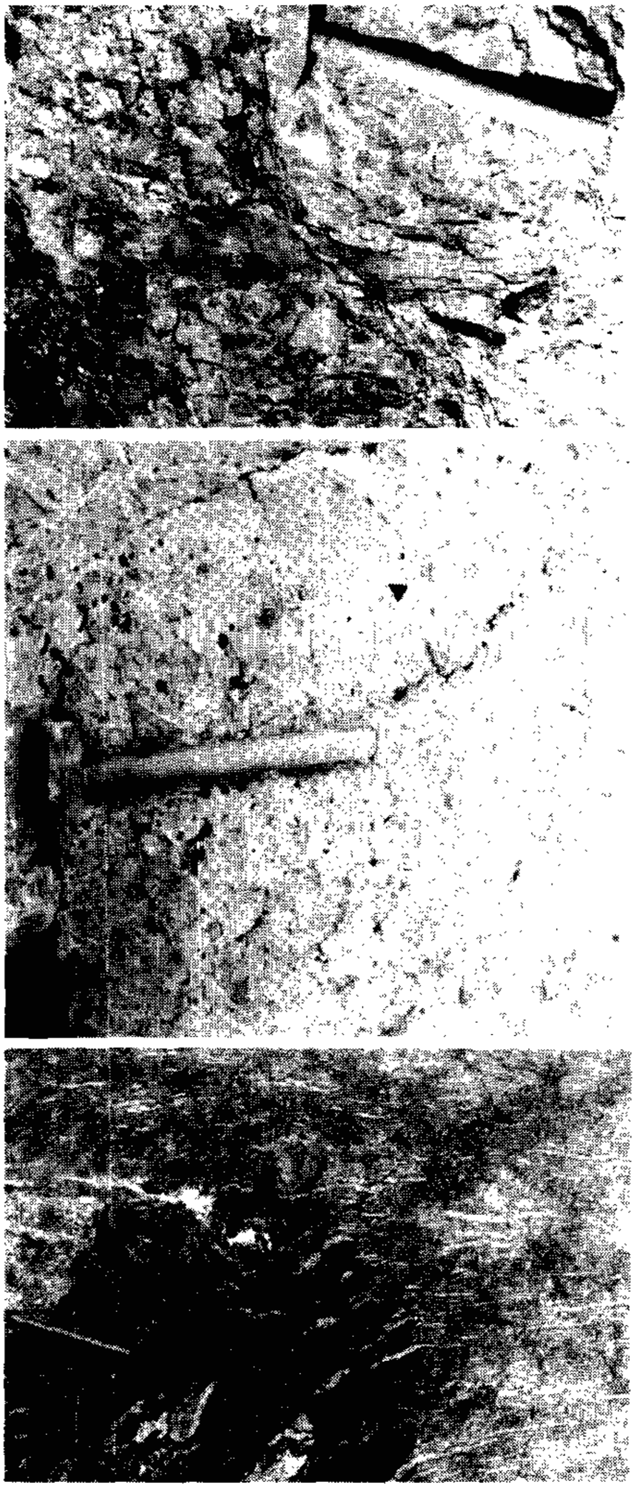

Photo 7a. Sloko volcanic sediments with carbonized wood and swamp grass debris; a palm frond stock is above the hammer. (b) Sloko welded ignimbrite flow with flattened pumice blocks up to 40 centimetres in diameter and 1 centimetre thick. (c) Sloko volcanic breccia; note partially welded bomb (at arrowhead).

DEBRIS FLOWS/BRECCIA/TUFFS

A thick fragmental sequence is composed of chaotic lapilli tuff to breccia and/or debris flows. These rocks are maroon to grey on fresh surfaces and light to dark grey depending on the overall felsic or mafic component. The fragments range in size from coarse ash to lapilli, but some are up to house size (Photo 8). Fragments are felsic to intermediate in composition and dominated by plagioclase porphyries.

Photo 8. Light coloured rhyolitic blocks contrast with darker matrix in a megabreccia on the east face of an unnamed peak north of Stuhini Creek. This unit is believed to have formed along a fault scarp; perhaps as an intracaldera facies.

FINE TUFF/TUFFITE

Interlayered ash to fine lapilli tuff, or tuffite, underlie the Niagara formation near Niagara Mountain. These range from fine-laminated, slightly pyritic, black ash tuffs or very fine grained siltstones to grey-blue, fine-grained bleached and silicified ash (lapilli) tuffs. All tuffs contain abundant feldspar fragments and minor fine volcanic lapilli fragments. The rocks weather rusty in areas where minor pyrite is present, to light brown-buff where the more extensive siliceous tuffs outcrop. The overlying Niagara formation conglomerate commonly scours and channels into these underlying lithologies, possibly obliterating them in some areas.

RHYOLITIC AND DACITIC VOLCANICS (FLOWS, LAHARS, BRECCIAS, TUFFS, WELDED TUFFS)

Rhyolitic and lesser dacitic volcanics constitute the basal units of the Sloko Group in some parts of the map sheet. The rhyolite flows vary from grey-white and massive to pinkish with fine flow bands and spherulites. Intimately associated with the flows are both lahars and breccias containing felsic volcanic fragments in a red, muddy matrix, as well as welded tuffs with flattened pumice fragments.

PLUTONIC ROCKS

Intrusive rocks in the Stuhini Creek map area can be grouped into three suites. Their age ranges can be only broadly assigned based on stratigraphic relationships, due to lack of isotopic age determinations. They are (?)Triassic to Cretaceous biotite hornblende diorite to tonalite, Early Eocene granite, monzonite and diorite and Eocene or younger granite and granodiorite.

TRIASSIC TO CRETACEOUS (?)

Weakly to moderately foliated hornblende tonalites to hornblende diorites are interpreted to be the oldest intrusives of the map area. They outcrop along the western map area boundary, on the northern flanks of Sittakanay Mountain. The rock is dominantly fine to medium grained. Hornblende is partly altered to epidote and chlorite.

EARLY EOCENE

This suite of plutonic rocks underlies a large part of the southeastern quadrant of the map area It is a series of east-west elongated, high-level, multiphase plutons and stocks. In outcrop, these intrusions weather white, light grey, tan, pink or orange. They are compositionally and texturally variable, ranging from fine to medium-grained quartz-feldspar-porphyritic monzonite and diorite to granite with as much as 15% biotite, magnetite, and/or hornblende. This variability probably results in part from different degrees of assimilation of large foundered blocks and scattered screens of volcanic and sedimentary country rocks. Contacts with solid country rock are sharp and chilled.

These plutons and stocks are spatially associated with, and most probably comagmatic with, Sloko Group volcanics; although they display a cannibalistic relationship. They are crosscut by northeast-trending faults resulting in brittle deformation and subsequent local alteration, hydrothermal alteration, and precious and base metal mineralization (*i.e.*, auriferous arsenopyrite with sphalerite and galena in clay alteration zones, and molybdenum along fractures in gossanous zones).

EOCENE AND YOUNGER

The youngest known plutons within the map area are pinkish grey medium-grained granite to tonalite bodies in the extreme northwest and southwest corners. They have long northeast-trending apophyses that extend far into the country rocks. Modal mineralogy of holocrystalline intrusions is 35 to 45% quartz, 20 to 40% orthoclase, 30 to 50% plagioclase and 5 to 15% biotite (less commonly with up to 10% hornblende). The intrusion in the southwest corner of the map contains spectacularly exposed, subequant xenoliths of Carboniferous tuffaceous rocks ranging from tens to hundreds of metres in length, indicative of high-level emplacement. The degree of xenolith assimilation (if any) is unknown.

Also included with this group of intrusions are subvertical dikes that comprise a swarm 6 kilometres wide that trends northeast from the toe of Sittakanay Glacier. Individual dikes are 2 to 50 metres thick. Together they comprise up to 50% of the rock mass over distances of several hundred metres, and about 10% over the width of the swarm. They are commonly porphyritic. In some instances, emplacement of these bodies appears to have occurred along northeast-trending faults.

QUATERNARY

Glaciation in the Stuhini Creek area is typical of many coastal regions where alpine glaciers are resilient remnants of a once widespread continental ice cap. The Quaternary history of this specific region is relatively poorly understood as no detailed Quaternary studies have been conducted. From the drainage pattern of the creeks and rivers, present-day glacier movement, glacial striae, P-forms and other paleoflow indicators found in the area, it is apparent that ice in the region flowed through the Sittakanay, Stuhini and Zohini stream valleys, into the Taku River valley and west toward the Pacific Ocean. The position of hanging valleys in the Taku River valley suggests a thickness of ice of approximately 580 metres.

Quaternary deposits in the area include terminal, lateral and medial moraines, lodgment and melt-out tills, glaciofluvial and fluvial accumulations, and colluvium. Any of these deposits may be, to some degree, reworked by fluvial and/or mass movement processes. Lacustrine deposits in the region are of limited areal extent.

Rapid retreat of thick ice sheets in the Coast Mountains has resulted in significant isostatic rebound. In response to this rebound, many creeks are deeply incised into U-shaped valley bottoms (Photo 9).

Photo 9. Rapid isostatic rebound in response to glacial retreat has resulted in streams deeply incised into U-shaped valley bottoms.

STRUCTURE

Deformation in the Stuhini Creek map area generally increases in intensity with the age of the affected strata, indicating a progression of widespread deformational events. Two to three folding events have affected Paleozoic strata, whereas, Tertiary rocks are generally block faulted and rarely tightly folded. Partitioning of high-angle brittle and ductile fabrics, particularly in the southwestern part of the map area, can in part be related to proximity of a major crustal structure, the Llewellyn fault zone. A second crustal-scale structure, the King Salmon fault, is associated with a Jurassic thrust belt that affects the northeastern quadrant of the map area. A series of Tertiary, high-angle normal and oblique faults is largely responsible for the juxtaposition of Mesozoic and Tertiary strata; although faults with the greatest amount of offset do not have the most prominent topographic expression.

MESOZOIC AND OLDER FOLDING

On Mount Sittikanay, pyroxene-phyric breccia and maroon lapilli ash tuff display two coaxial northeast-trending, high-amplitude chevron fold sets (Mihalynuk *et al.*, 1994a). They are also deformed by a more open set of north-northwest-trending folds. However, relationships that clearly demonstrate the relative ages of these folds are lacking.

On Mount Jeane, tight east-west minor folds crop out in the core of a late (Eocene), open, northwest-trending antiform. Elsewhere within Mesozoic strata of the northern map area, northwest-trending folds are open with wavelengths of 1 to 3 kilometres. These folds affect the youngest Laberge Group strata which are unconformably overlain by Eocene Sloko volcanics unaffected by the folding. This widespread folding is believed to be early Middle Jurassic in age; part of the same deformation event that produced the King Salmon thrust belt.

TERTIARY FAULTING AND FOLDING

High-angle normal, reverse and oblique-slip faults were the most widespread structural modifiers of Eocene and post-Eocene geology. Two major episodes of high-angle faulting can be resolved. A dominantly easterly oriented set has individual vertical offsets that may exceed 2 kilometres, and are in part synchronous with deposition of Eocene Sloko Group rocks. These faults are cut by a later northeast-oriented set of Eocene and younger(?) faults with dip-slip offsets generally less than 500 metres. Late faults typically have a greater topographic expression than earlier faults that have greater offset.

Folding of Tertiary strata is induced by drag along major block faults; by draping of volcanic strata over preexisting topographic irregularities, and apparently, by compressional deformation acting locally over areas of less than a few hundred square kilometres.

Drag folds affect both Tertiary and Mesozoic rocks along faults that juxtapose the two. One of the best examples is well displayed on the southwest face of Mount Jeane. Here Laberge rocks have been down-warped adjacent to down-dropped Sloko Group volcanics (Photo 2). Warping of some Tertiary strata may have been synchronous with their deposition. An example of this is seen on the ridge between Zohini and Red Cap creeks. Here, Eocene strata steepen and thin northward toward a high-standing Laberge Group fault block. These rocks contain a significant proportion of Laberge Group clasts, probably derived from the Laberge block as it was uplifted to form a fault-basin for Sloko Group deposition.

Paleozoic rocks were subjected to older regional deformational events, making it difficult to resolve the affects of late block faulting. Block faults do however, bring Paleozoic rocks to the surface. On the northeast face of Mount Erickson, Paleozoic and Tertiary strata are juxtaposed across a high-angle reverse fault (Photo 10). If our interpretation of Sloko Group offsets are correct, the Mount Erickson fault has a minimum vertical displacement of about 2 kilometres.

LLEWELLYN FAULT ZONE

Mihalynuk *et al.* (1994a, b) traced the Llewellyn fault from Atlin Lake, south through the Tulsequah River area, but lost it in the broad Taku River valley. No single dominant trace of the fault could be identified south of the Taku. Field observations reported here confirm an apparent fanning of the Llewellyn fault with distribution of ductile and later brittle faults over several widely spaced traces. Two of these traces are interpreted to affect Paleozoic strata underlying Mount Sittikanay. Deformation along the fault splays is dominated by ductile fabrics at this structural level. As mapped, the fault strands juxtapose locally foliated Paleozoic volcanics with Triassic volcanics in which intense ductile fabrics are less commonly developed.

KING SALMON THRUST BELT

Souther (1971) mapped the King Salmon thrust as a structural discontinuity that is focused at the base of Upper Triassic Sinwa carbonate. However, this overthrust event probably affected a belt of rocks that extends west to Red Cap Creek where a complexly deformed, west-verging imbricate stack of Jurassic and perhaps Triassic strata is exposed. It may even extend to west of Mount Jeane, where low-angle fault cutoffs are well exposed in cliff faces (Photo 2). Unfortunately the nature of this compressional deformation event is masked by later block faulting, and in the western part of the map area, by thermal overprinting by the Coast intrusions.

Age of thrusting is constrained outside the map area, near Cry Lake, to be Toarcian to middle Bajocian (Thorstad and Gabrielse, 1986). More recent evidence from farther south, suggests that initiation of thrusts like the King Salmon, responsible for emplacing oceanic Cache Creek Terrane above Stikinia, is recorded in latest Toarcian to Aalenian strata of the basal Bowser Lake Group (Ricketts and Evenchick, 1991). Jurassic Laberge

Photo 10. A well exposed high-angle reverse fault along the base of Mount Erickson (at Bruce's feet) that juxtaposes deformed basalt of probable Paleozoic age (to right) with quartz-phyric breccia (left of fault) here assigned to the Eocene Sloko Group

Group strata of the Stuhini Creek area also record this event with deepening of the basin in late Toarcian time, and introduction of chert-granule conglomerate, presumably derived form uplifted Cache Creek Terrane, in the early Bajocian. A corollary of Bajocian Laberge Group deposition in the Stuhini Creek area is that overthrusting of the Sinwa Formation by the King Salmon fault could not have extended as far west as the map area before Bajocian time.

MINERAL PROSPECTS

A wide variety of mineral occurrences are found in the Stuhini Creek map area. Paleozoic strata contain volcanogenic massive sulphide accumulations, Tertiary intrusions at the Red Cap have reported porphyry copper potential, and Tertiary volcanics host base metal sulphide veins with sporadic, elevated gold and silver values. Four occurrences are well explored prospects, and have been drilled: base metal sulphide lenses at the Erickson-Ashby; auriferous antimonial shear-hosted veins at the Zohini; antimonial veins at Red Cap and auriferous arsenical porphyry-hosted veins at the Go.

Field mapping in 1994 provided new data on known occurrences, helped to further outline volcanogenic massive sulphide potential in Paleozoic rocks and resulted in the discovery of three significant metal sulphide vein occurrences. These new occurrences are tetrahedrite-chalcopyrite-sphalerite veins at the Lisadele; galena-chalcopyrite-sphalerite veins at the Blackfly, and chalcopyrite-magnetite veins at the Oksarah. A number of smaller showings or indicators were also discovered and are reported on below.

ERICKSON-ASHBY

The Erickson-Ashby property is an advanced prospect which was discovered in 1929 by two prospectors (Erickson and Ashby). Since 1929 most assessment work was performed to maintain the claims in good standing, however, the property has been subjected to geological mapping, geochemical sampling, trenching and diamond drilling. An adit was driven adjacent to one of the mineralized zones in 1964.

The property is underlain by probable late Paleozoic volcanic and associated sedimentary lithologies cut by Tertiary granitic dikes. They consist of massive to locally brecciated and epidotized basalts and andesites interlayered with lesser purplish siltstones, cherty siltstones, cherty argillaceous carbonate, and carbonate with mafic volcanic clasts. Payne (1979) reports that rhyolite and rhyolitic tuffs are present within the sedimentary intervals, however, these rock types were not encountered during our limited examination. All lithologies are hornfelsed; basalts and andesites to a lesser degree than the more porous sedimentary rocks. Mineralization is restricted to cherty and carbonate intervals, and has been described as being syngenetic volcanic (VMS) in origin (Payne, 1979) and epigenetic skarn mineralization (Bernius, 1963; Bojczyszyn, 1988).

Lithologies are cut by a north-northeast-trending dextral fault (Bracken fault) with a maximum offset of up to 200 metres. Southeast of the fault are interlayered basalts and andesites and sedimentary exhalatives, whereas to the northwest are mostly siltstones and interlayered exhalatives. Mineralization is present on both sides of the fault but is more extensive and higher grade to the southeast (Payne, 1979).

Mineralization occurs within at least thirteen different zones, each of which contains one or more discontinuous lens-shaped bodies of disseminated to massive sulphide (Payne, 1979). The sulphides are almost exclusively a mixture of pyrrhotite, sphalerite, pyrite, and galena. Assemblages range from massive pyrrhotite or pyrite with up to 25% sphalerite and galena, to massive sphalerite or sphalerite and galena in equal proportions. Malachite staining is visible on weathered surfaces, but no other copper minerals were seen. Analysis of a sample collected during our examination returned 1.57% Pb, greater than 10% Zn, 258 g/t Ag and negligible copper (see sample SSE94-42.100, Table 3). Mineralization cuts across the sedimentary layering but the bounding mafic flows are not mineralized.

Base metal assemblages, associated hostrocks and the location of the mineralized pods suggest that sulphide accumulation was syngenetic with the enclosing sediments, probably during a hiatus in basaltic/andesitic volcanism. The present skarn mineralogy (actinolite-rhodonite-diopside-tremolite-magnetite) represents a later contact metamorphic effect due to intrusion of nearby monzonitic sills. An increased thermal gradient seems to have succeeded only in recrystallizing the sulphides with little sulphide remobilization.

GO-1

The Go-1 claims covers mineralized portions of a Tertiary quartz monzonite stock east of Mount Lester Jones. Mineralized sections consist of gold±silver-bearing arsenopyrite within planar, light-coloured alteration zones that strike 110° and dip 75° south. Within these zones, feldspar and hornblende are replaced by phyllosilicates. Carbonate alteration (siderite) is pervasive, but epidote and chlorite alteration is conspicuously absent. Arsenopyrite and pyrite are the dominant sulphides with locally abundant pyrrhotite, chalcopyrite, galena, sphalerite, and stibnite (Lintott, 1981). Nine holes were drilled in 1981 with the best assays returning 7.1 g/t Au and 514 g/t Ag over 13 centimetres (Lintott, 1981). No base metal assays have been reported.

A brief examination during regional mapping revealed that there are at least eleven separate drill collars and three small blast pits. Analysis of a grab sample of intergrown green quartz and arsenopyrite from one of these pits yielded values of 0.26% Cu, 0.44% Pb, 190 g/t Ag and 8 g/t Au (see Table 3, number MMI94-45.070).

GOAT CLAIMS

The Goat Claims blanket the south flank of Mount Metzgar west of the Taku River. Minor disseminated pyrite, sphalerite and chalcopyrite are locally present in the underlying felsic and intermediate tuffs, andesite, volcanic sandstones, and the variably graphitic argillites. Reported assays are very low with the best sample returning 0.19% Zn from a rhyolitic tuff (Photo 5 in Sorbara, 1983). Weak horizontal-loop EM and magnetic anomalies are generally associated with graphitic portions of the argillites.

In the course of regional mapping, traverses were made both north and south of the main exploration focus at the Goat claims. While no good rhyolite units were observed, indications of mineralization were encountered. Massive sulphide boulders were discovered in moraine to the north (see Other New Occurrences) and minor lead-zinc mineralization occurs in hornfelsed sediment to the south (0.4% Pb and 0.3% Zn; Table 3, number MMI94-42.020).

ZOHINI

The Zohini occurrence is a shear-related auriferous and antimonial base metal sulphide vein with good continuity, hosted by Sloko Group volcanic strata. Mineralization within the shear zone averages about 2 metres in width, but ranges up to nearly 8 metres. In 1994, a series of ten short diamond-drill holes tested the northern and down-dip extensions of the vein. Results of the drill program are pending.

RED CAP

An impressive gossanous alteration zone is developed within volcaniclastics and a polyphase porphyry intrusion at the Red Cap property. Anomalous copper, molybdenum and silver in soil samples across the alteration zone were thought to indicate porphyry potential. However, a series of six short drill holes (up to 7.2 metres) showed lower bedrock grades than indicated by the soils (Archer, 1972). Subsequent deeper drilling and geochemical surveys also failed to locate porphyry-style mineralization although stockworks of thin quartz veins with elevated gold and polymetallic sulphide veins were discovered (Rye, 1991, and references therein).

Three field traverses were made over the Red Cap property in 1994. A propylitic alteration zone extends well into clastic country rocks. This is overprinted by biotite and local strong bleaching and argillic alteration within the gossanous cap. A sample from this alteration zone returned 0.1% Cu (Table 3, number MMI94-9.060). A nearby quartz-flooded zone a few square metres in extent, returned 2.7 g/t Au (Table 3, number MMI94-9.080). Bounding Red Cap to the east is an extensively quartz veined fault zone; quartz veins and chalcedonic breccias are 10 to 20 metres wide. One sample collected from this zone (MMI94-11.070) showed no elevated metal values.

Although low-grade mineralization at the Red Cap lacks continuity, widespread alteration and extensive vein sets indicate a substantial hydrothermal system.

NEW SHOWINGS

Three new showings were discovered in the course of our regional mapping. These are persistent base metal veins (Oksarah, Lisadele) and vein networks (Blackfly) with contained gold values of less than 2 grams per tonne. Several less significant indications of mineralization were also encountered and are reported below.

OKSARAH

A set of subparallel veins are foliated to varying degrees within greenstone that displays rare relict pillows. Most continuous of these is a chalcopyrite vein, 15 to 70 centimetres wide, that can be traced for about 75 metres (Photo 11). A set of magnetite-chalcopyrite veins up to 20 centimetres wide is oriented roughly orthogonal to the main chalcopyrite vein set. Assays from the widest veins of these two sets are, respectively: 6.4% and 0.6% Cu, 279 g/t and 10 g/t Ag (see Table 3, numbers MMI94-23.021 and 022). Vuggy, quartz-flooded breccia zones up to 10 metres wide and several hundred metres long are spatially associated with the copper-silver mineralization, but do not have elevated metal contents. Wide-

Photo 11. A chalcopyrite vein at the Oksarah showing (dark and hackly) extends from the foreground, where it is 70 centimetres wide, to beyond the treed horizon, where it thins to 15 centimetres. Magnetite veins up to 20 centimetres thick form a set oriented roughly perpendicular to the main vein.

TABLE 3. ASSAY DETERMINATIONS FOR SELECTED SAMPLES FROM THE STUHINI CREEK MAP AREA.

Sample number	*UTM*		*Cu*	*Pb*	*Zn*	*Ag*	*Au*	*Mo*	*Co*	*Fe*	*As*	*Sb*	*Ba*	*NOTES*
	easting	*northing*	*%*	*%*	*%*	*ppm*	*ppb*	*ppm*	*ppm*	*%*	*ppm*	*ppm*	*ppm*	
BMA 94 21.030	597350	6509000	0.10	1.20	0.03	160.4	15600	1	121	16.42	16934	10796	2	Zohini vein at surface
DMF 94 20.010	605800	6503000	0.00	0.00	0.00	1.5	510	88	49	0.73	189	5	65	Gossan, Stuhini-Zohini headwaters
MMI 94 9.060	599850	6512350	0.10	0.00	0.00	1.1	77	1	126	12.64	23	5	18	Alteration at Redcap
MMI 94 9.080	600750	6512150	0.00	0.00	0.00	0.4	2700	1	36	1.04	9751	110	38	Quartz stockwork at Redcap
MMI 94 11.050	601300	6512200	0.60	0.14	0.28	101.1	3340	5	165	20.41	>10%	394	4	Red Cap trench
MMI 94 11.070	601550	6511000	0.00	0.01	0.00	0.7	54	64	100	0.78	143	6	162	Red Cap quartz-flooded zone
MMI 94 15.010	609600	6507750	0.03	0.02	0.03	2.1	124	11	78	6.94	3515	11	25	upper King Salmon Creek
MMI 94 16.070	607400	6488650	0.32	0.08	0.32	43	16	11	84	10.24	12	6	22	float on glacier
MMI 94 19.031	614300	6503300	2.26	0.59	0.23	164	683	10	158	8.44	2084	12929	8	Lisadelle
MMI 94 19.032	614300	6503300	2.18	1.80	0.80	161.8	579	5	186	7.94	4199	9767	16	Lisadelle
MMI 94 22.050	599000	6504500	0.22	1.71	2.73	151.6	3	223	75	5.2	27	8	7	Blackfly breccia
MMI 94 22.060	599050	6504450	1.85	0.71	0.15	209.2	5	56	121	9.96	86	12	18	Blackfly galena lens
MMI 94 22.072	599000	6504200	0.00	0.01	0.00	0.6	b.d.	15	59	1.31	24	34	63	Blackfly quartz-flooded country rock
MMI 94 22.080	drill	core	0.02	1.47	4.01	148.5	9650	1	2	5.83	159	14499	4	Zohini drill intersection DDH94-Z10 84.03-83.93 m
MMI 94 23.021	*615350*	*6492400*	*6.44*	*0.02*	*0.04*	*278.7*	*39*	*6*	*194*	*25.34*	*47*	*21*	*11*	Oksarah 0.7 *m chalcopyrite vein*
MMI 94 23.022	615350	6492500	0.62	0.00	0.03	10.4	b.d.	1	248	15.75	55	3	22	Oksarah 0.2 m magnetite vein
MMI 94 23.023	615250	6492350	0.00	0.00	0.00	0.5	12	7	120	1.83	28	4	40	Oksarah quartz-stockwork/silicified country rocks
MMI 94 26.020	604550	6486600	0.05	0.26	2.72	27.1	4	41	60	5.13	6	2	20	Fault gouge in Sloko volcanic strata
MMI 94 30.030	599500	6501150	0.01	0.00	0.00	121.2	210	21	85	1.41	164	4	47	Bull quartz vein near Niagara Mtn.
MMI 94 37.090	587150	6510500	0.00	0.00	0.00	0.1	b.d.	5	69	16.05	8733	93	4	Massive sulphide boulder Mt. Metzgar
MMI 94 42.020	*587600*	*6508650*	*0.03*	0.42	0.31	7.7	65	1	25	4.59	344	5	4	*Goat claim*
MMI 94 43.030	603000	6511500	0.06	1.14	1.15	28.5	13	1	47	3.92	50	9	5	Stuhini conglomerate; 5 cm chalcopyrite-galena vein
MMI 94 45.070	607250	6509250	0.24	0.45	0.03	190.2	13400	1	175	25.54	>10%	1956	4	Go-1 trenched arsenopyrite mineralization
SSE 94 36.030	612750	6497900	0.00	0.00	0.01	0.3	212	7	85	19.77	1531	7	12	Gossanous zone - east map area
SSE 94 42.100	588850	6502600	0.00	1.57	>10	257.7	-38	6	20	4.12	4799	3551	2	Ericksen Ashby sulphide pod
SSE 94 47.050	611400	6491050	2.69	0.00	0.00	90.6	6	8	62	4.16	6	2	76	Float boulder in eastern map area

Au analyses are by instrumental neutron activation. Other elements are analysed by Inductively Coupled Plasma Emission Spectroscopy. A 0.500 g sample is digested in 3 ml of 3-1-2 $HCl\text{-}HNO_3\text{-}H_2O$ at 95°C for one hour and is diluted to 10 ml with water; it is partial for Fe.

spread deformation and metamorphism have obscured primary textures, thus the source of mineralization is uncertain. A hydrothermal origin is possible, but quartz, carbonate or other gangue minerals are scarce. A volcanogenic origin is supported by the submarine setting of the hostrocks (as indicated by relict pillows), but sulphides occur as veins both within and cutting fabrics that are interpreted to be much younger than the hostrocks.

BLACKFLY

Mineralization at the Blackfly showing is focused within the basal Sloko Group, just above its contact with Laberge Group strata on the west ridge of Niagara Mountain (Photo 12). Acicular hornblende porphyry hosts an irregularly spaced (5 to 10 m) network of veins and linear breccia zones up to 50 centimetres wide (more commonly 5 to 10 cm). A probable hypabyssal origin for the porphyry hostrocks is indicated by a lack of volcanic textures and large, quartz-lined, miarolitic cavities. Galena, sphalerite, quartz, epidote and chalcopyrite dominate the vein assemblage. In one case, a lens of nearly pure galena occupies a vein segment 2 metres by 30 centimetres in cross-section. Analysis of grab and chip samples returned values up to 1.9% Cu, 1.7% Pb, 2.7% Zn and 209 g/t Ag (see Table 3, numbers MMI94-22.050 to 072).

Because units hosting the Black Fly are ridge-cappers, they have been largely removed by erosion. We were unable to trace the relatively flat-lying mineralized zone around either side of the ridge during our preliminary investigations. It may be limited to an area of roughly 50 by 125 metres. However, similar mineralization is reported on the adjacent Niagara 8 claim block (Aspinall, 1991) centred about 1 kilometre to the east, well within the Laberge group rocks.

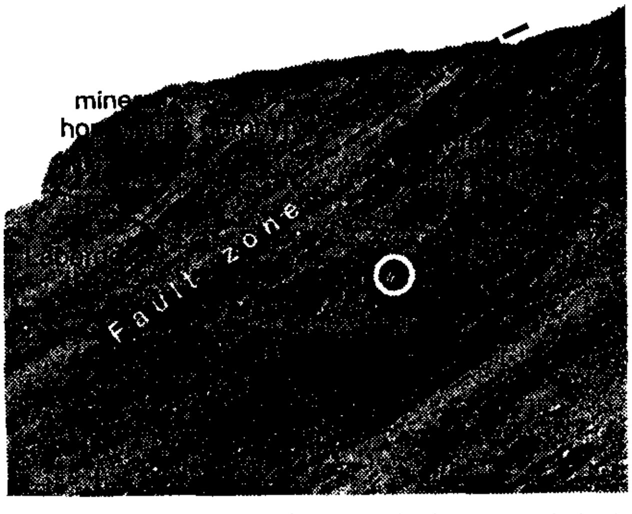

Photo 12. Galena-chalcopyrite mineralization at the Black Fly showing occurs as an irregularly spaced (5-10 metres) network of veins and linear breccia zones up to 50 centimetres wide on the west ridge of Niagara Mountain. This mineralization is best developed where Sloko Group hornblende porphyry (resistant, dark-weathering) crops out above Laberge Group argillite (more lightly coloured and rubbly).

Photo 13. A view northwest along strike of the Lisadele occurrence at the contact between resistant Sloko Group and underlying, relatively recessive Laberge Group strata. Parallel tetrahedrite-chalcopyrite-sphalerite veins 1 to 5 centimetres wide, can be traced along strike for at least 125 metres. Mount Lester Jones is on the far left horizon. Flat-lying Sloko Group rocks cap folded Laberge Group strata in the near right horizon.

LISADELE

The Lisadele occurrence is at the contact between Sloko and Laberge Group strata (Photo 13). Parallel tetrahedrite (± very fine grained ?stibnite and galena)-chalcopyrite-sphalerite veins 1 to 5 centimetres thick (rarely to 40 cm), extend for at least 125 metres along strike and are focused in a zone 5 metres wide, but occur widely spaced over a width of about 40 metres perpendicular to strike (Photo 13). The best analytical results are 2.2% Cu, 1.8% Pb, 0.8% Zn and 161 g/t Ag (see Table 3, numbers 19.031 and 032).

OTHER NEW OCCURRENCES

Molybdenite found near the extreme southeast corner of the map area is now named the Missing Creek occurrence (Figure 3, ▲1). Patchy molybdenite is present with fine-grained cubic pyrite along fracture surfaces in a gossanous zone within grey, fine to medium-grained granitoid intrusive composed of subhedral plagioclase (70%), quartz (15%), and biotite (15%). This gossanous zone also includes infrequent, 3 to 5-centimetre 'knots' of massive pyrite, presumably filling cavities. The attitude of the zone is undetermined, however it is present in outcrop for 10 to 12 metres along the stream.

A narrow vein (<1 cm) of massive chalcopyrite was found in granitic float in the southeast part of the map area (Figure 3, ▲2). The float is composed of quartz eyes and light green, altered plagioclase feldspars (together totaling 10 to 15%) in a fine-grained, pinkish brown groundmass. Minor mafic minerals are also present in the groundmass. Fractures are mostly coated with malachite. Granitic rocks outcropping in this area overlie a sequence of plagioclase-phyric volcanics and lesser lapilli tuffs. Epidote alteration is common near the granitic-volcanic contact. The nature of the surrounding topography indicates that the copper-rich float is probably sourced locally from the south-southwest.

Massive crystalline barite float has been found at three locations. The first is on the southeast face of Mount Lester Jones (Figure 3, ▲3) and consists of a 100 by 40-centimetre boulder of very coarse grained barite and lesser, crudely formed barite rosettes. Smaller boulders of similarly crystalline barite also occur in a small cirque approximately 2 kilometres north of Mount Jeane (Figure 3, ▲4). The coarse crystalline nature of the barite from these two float occurrences suggests a hydrothermal vein origin. However, in the latter case, the barite is spatially associated with submarine arc volcanic rocks and could be exhalitive.

The third occurrence of barite float is on the north side of Mount Lester Jones near an intrusive contact (Figure 3, ▲5). The barite here is medium to coarse grained and partially intergrown with crystalline quartz.

Boulders comprised almost entirely of fine-grained massive pyrite occur along the southern terminus of an unnamed glacier originating on the east face of Mount Metzgar (Figure 3, ▲6); they have apparently not been seen prior to our field mapping. These boulders are angular and up to 30 centimetres in diameter. They form an isolated train that rests on scoured bedrock of the Paleozoic Stikine assemblage. The boulders occur within about 20 metres of the margin of glacial ice and may have been melted out in just the past few years. Airphotos of 1974 vintage indicate that the area was more extensively snow covered at that time. The boulders are about 1 kilometre north of the Goat Claim block, but are not mentioned in assessment work reports (Sorbara, 1983).

Almost certainly the sulphide boulders are derived from the eastern cirque of Mount Metzgar. A traverse across the headwall of the cirque failed to identify areas of sulphide mineralization; although access to outcrops was limited by extensive bergschrund development. At the head of the cirque is a section of massive to well bedded rusty chert; a conspicuous unit that carries through to the north side of the mountain where it was mapped in 1993 (Mihalynuk *et al.* 1994b). Other lithologies include: brown, bioclastic limestone, vesicular basalt breccia, carbonate debris flows, sulphidic siliceous argillite, pillow breccia and tuffaceous turbidites. Considered collectively, the units most closely resemble the middle Pennsylvanian portion of the Mount Eaton succession. Extensive structural disruption at Mount Metzgar, including thrust faults that are well exposed on the northern face, may interleave a wide range of Paleozoic strata.

Analysis of the boulders indicate near background levels of copper, lead and zinc. Nevertheless they are an important exploration indicator in the immediate area.

GEOLOGIC HISTORY AND SUMMARY

The geological history of the Stuhini Creek area is summarized diagrammatically in Figure 6. Pre-Tertiary geology is mainly a product of two episodes of arc building and dissection. Arc rocks include Mississippian to Permian volcanics of the Stikine assemblage that probably represent at least three major arc-construction pulses in the early Mississippian, middle Pennsylvanian and Early Permian; and Upper Triassic volcanics of the

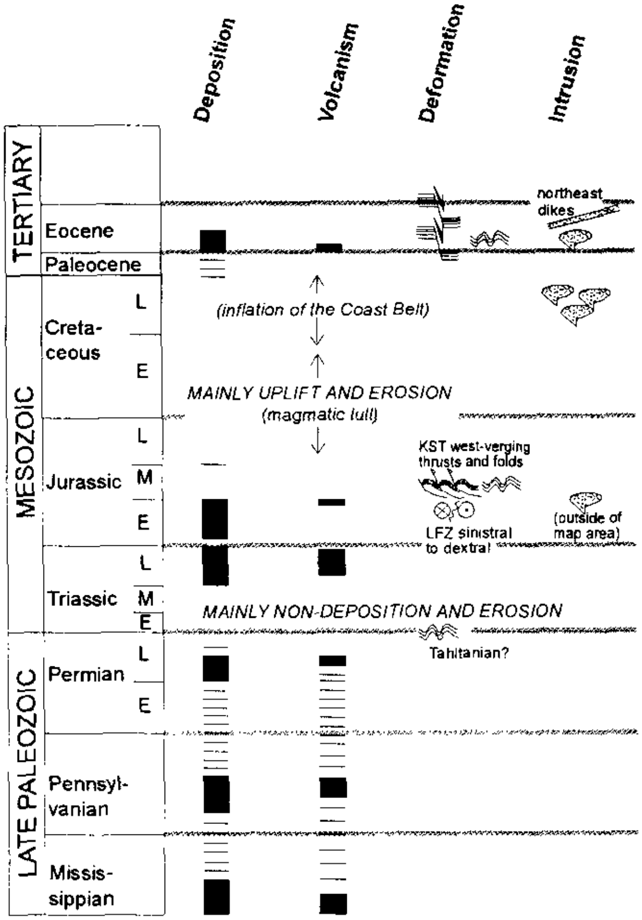

Figure 6. Summary diagram showing the geological history of the Stuhini Creek map area.

Stuhini Group. Early Mississippian felsic volcanism is particularly important because of local syngenetic massive sulphide accumulations (*i.e.*, Big Bull and Tulsequah Chief deposits to the north). Sulphide deposition at the Erickson-Ashby deposit may be coeval, but age data are currently lacking.

Evidence of Late Permian to Middle Triassic deposition appears to be absent. Perhaps this is a consequence of the Triassic global rise in sea level, or perhaps to removal of these strata during a pre-Upper Triassic deformational event known as the Tahltanian orogeny (Souther, 1971). However, the Tahltanian orogeny is not clearly manifest in the Stuhini Creek area.

The nascent Stuhini arc was presumably constructed on a Paleozoic arc substrate, however, there is no clear evidence of this in the map area. Generally, contact relationships are obscured by later faulting. Axial portions of the Stuhini arc appear to have lain mainly west of the map area; a coarse volcaniclastic arc-apron displays a northeastward (basinward?) increasing sedimentary component and northeast paleoflow.

Cessation of volcanism and uplift of the Stuhini arc in the Early Jurassic led to deep arc dissection and production of volcanic clast dominant conglomerate, followed by igneous clast dominant conglomerates of the Laberge Group. Arc dissection gradually waned, decreasing the production of coarse detritus. Aggradation of the basin in which Laberge strata accumulated slowed dramatically. Intermittent debris flows delivered coarse detritus from the lowest levels of Stuhini arc dissection, represented by metamorphic clast rich conglomerate.

Initial emplacement of the Cache Creek Terrane onto the inboard edge of the Stikine-Stuhini arc complex caused a late Toarcian to Aalenian deepening of the basin. Continued obduction resulted in a westward-migrating deformation front with major detachments localized near the top of the Stuhini Group (*i.e.*, King Salmon thrust; see Monger, 1980). Uplift and erosion of the oceanic Cache Creek Terrane is reflected in deposition of chert-pebble conglomerate within the youngest basinal strata. Deformation culminated in Bajocian time resulting in a period of non-deposition and erosion.

Continental-margin arc magmatism that ensued in the Late Cretaceous, caused mainly inflation and uplift of the Coast Belt. In the Early Eocene, large-scale block faulting of eroded Mesozoic and Paleozoic strata accompanied voluminous felsic volcanic outpourings and edifice construction. Hydrothermal circulation locally focused along this unconformity resulted in the formation of vein occurrences such as the Black Fly and Lisadele. Hydrothermal circulation restricted to fault zones produced veins like the Zohini. Small, mineralizing stocks of this age may be represented by the Red Cap prospect.

Remobilization of Eocene and older faults and sculpting by Pleistocene to Recent glaciation have dispersed mineralization at surface and produced the landscape present today.

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