803596 John Payne's Report for Granges Inc. 1 Oct. '91

GEOLOGY of the UNUK and COUL CLAIM BLOCKS Stikine Mining District

PART A: REGIONAL and PROPERTY GEOLOGY

1.Ø INTRODUCTION

The geology of the region has been studied by many authors over the last several years, but interpretation still remains unclear because of complex structure, rapid facies changes, and lack of sufficient critical fossil and radiometric dates. Major regional problems exist in assignment of ages to and correlation of certain lithological units. On the property, the major uncertainty of correlation is of the rocks in the fault block along the Unuk River. Some controversy exists as to the age of the felsic units on the slope east of Unuk River.

Fossils collected in this study were shown to Tim Tozer of the Geological Survey of Canada in Vancouver, an expert on Triassic fossils, and have been sent to Genga Nadaranja of the Mineral Deposits Research Unit for further study. Radiometric dating of some rocks in the region are planned by the Mineral Deposits Research Unit and the Geological Survey of Canada. Both these techniques will help unravel some of the uncertainties regarding the geological history of the region.

During the present study, concurrent studies were being made on the property and surrounding regions by Rod Kirkham, Jack Henderson, and Mariette Henderson of the Geological ~~Association~~ Survey of Canada, and by Peter Lewis and Roland Bartsch of the Mineral Deposits Research Unit. Their work and our discussions with them were helpful to our understanding of the regional geology. Some of their data and ideas are incorporated in the maps and text, respectively, in this report. The seminar at Bronson on July 28th also provided useful discussion of regional problems.

2.Ø REGIONAL GEOLOGY

2.1 Regional Geological Setting

The property is in the Stikine terrain of the Intermontaine tectonic belt near the western border of the Middle Jurassic Bowser Basin (Figure 1, after Anderson, 1991). It is underlain by up to 7 kilometres of Upper Triassic to Lower Jurassic volcano-sedimentary arc-complex lithologies of the Stuhini and Hazelton Groups. The Hazelton Group consists of, in order from oldest to youngest, the Unuk River Formation, the Betty Creek Formation, and the Mount Dilworth Formation. These rocks are capped by Middle Jurassic marine-basin sedimentary rocks of the Salmon River Formation and/or Bowser Group. Some authors would include rocks of the Salmon River Formation as part of the Hazelton Group, whereas others would group these rocks with those of the overlying Bowser Group.

The stratigraphic sequence ~~was~~ is cut by plutons and dykes representing four major intrusive episodes ranging in age from Late Triassic to Tertiary. As well, granitic boulders in a distinctive conglomerate at the top of the Stuhini Group indicate an earlier, as yet undated plutonic event in the region. The high potassium content of many of the Stuhini mafic volcanic rocks suggests contamination by a pre-Triassic sialic basement.

2 is map

Two major unconformities occur in the sequence, one at the top of the Stuhini section, and another at the base of the Mount Dilworth Formation in the Upper Hazelton. The Stuhini Group rocks were deformed prior to deposition of rocks of the Hazelton Group. A third unconformity probably exists between the Mount Dilworth Formation and the overlying rocks of the Salmon River Formation and Bowser Group.

3.0 PROPERTY GEOLOGY - STRATIGRAPHY

The property geology is shown in Figures 2 to 5. Detailed geology of areas of economic interest are described in PART B.

3.1 Stuhini Group

= your McTagg Anticlinorium. - I like yours better! - I'll change mine

Rocks of the Stuhini Group are exposed in the core of a broad anticlinorium, herein defined as the Unuk River Anticlinorium, whose axial zone crosses the property east of the Unuk River. In the south it trends north-south just east of Lower McTagg Creek, and to the north it trends northeast and is more diffuse.

the axial zone

The oldest rocks exposed in the core consist of a sequence of clastic sedimentary rocks, dominated by well and finely bedded turbidite sequences of mudstone, siltstone, and fine wacke, and a few distinctive layers and intervals of coarser grained, more massive arkosic wacke. Some plagioclase-rich wackes weather a characteristic light grey, but have a distinctive black color on the fresh surface caused by abundant carbonaceous opaque in plagioclase crystal fragments and in the groundmass. A fossil occurrence on West McTagg Ridge on the west limb of the anticlinorium yielded a poorly preserved Halobia, indicating a Karnian age (Tim Tozer, pers. comm.).

I never heard of this before?

Higher in the section are lensy intervals up to a few tens of metres thick of mafic and intermediate volcanic rocks interlayered with intervals of sedimentary rocks, the latter generally similar to those lower in the section. Volcanic rocks are dominated by flow and debris breccias, in part with moderately abundant, well rounded fragments of intermediate to mafic volcanic flow and hypabyssal rocks. With increasing abundance of rounded fragments, the debris breccia grades into immature volcanic conglomerate.

Northeast of Jack Glacier are three localities of Monotis(a characteristic Norian (Upper Triassic) fossil). Two are on Jack Ridge, one on either limb of the Unuk River Anticlinorium, and the third is to the north in the north-facing nose of the anticlinorium on Copperkopf Ridge. The last was reported previously by Anderson; the other localities are newly reported. They may represent a single time-horizon. Just north of the Monotis locality on Copperkopf Ridge are two limestone beds containing numerous non-diagnostic fossils including a large gastropod, rugose and fixed corals, branching bryozoa, and a crinoid stem. Rocks here locally dip to the south, so the stratigraphic relationship with the Monotis locality is uncertain. Minor limestone intervals are scattered elsewhere in the section, and some other mudstone and siltstone intervals are slightly to moderately calcareous.

In the southeast corner of the property is a distinctive interval containing up to 50% beds of pebble to fine cobble conglomerate, in

which almost all fragments are of fine grained, clastic sedimentary rocks. These are interlayered with coarse to fine wackes and minor well bedded siltstone and mudstone intervals.

On the northeast side of Jack Glacier about half-way up the section is a sedimentary interval a few metres thick containing abundant conglomerate beds with rounded pebbles and cobbles dominated by volcanic rocks with much less abundant but distinctive ~~ones~~ of limestone. No granitoid cobbles were recognized.

On the west and northwest limb of the anticlinorium, at or near the top of the section is a thick sequence of mafic volcanic flows, flow and debris breccias, and much less finer tuffaceous rocks of similar composition. Some of the flows have distinctive, well formed pillows up to several metres in size. Some pillows have characteristic shapes with rounded tops and pointed bottoms, which indicate the facing direction to the west. On Lawrence Ridge, one such distinctive pillowed flow ends abruptly against a section of turbidites showing abundant features formed by soft-sediment deformation. Such rapid facies changes are common, and complicate stratigraphic correlation.

Some mafic flows and breccias contain distinctive pyroxene phenocrysts, whereas others are characterized by plagioclase and less commonly by plagioclase and hornblende phenocrysts. An unusual feature of many of them is that they contain abundant K-feldspar in the groundmass, and the chemical analysis gives 4-6% K2O. This appears to be primary rather than secondary. Chemical analyses are shown in Appendix ___. The origin of the magma is interpreted as having been a normal mafic magma contaminated by K-rich crustal material.

In the northern part of the property and beyond, the upper mafic volcanic section is overlain by a section up to several tens of metres thick of well and finely laminated turbidites. Towards the top of this interval, thicker beds of wacke become prominent and the wacke approaches an arkose in composition. On the northeast side of Jack Glacier, in the middle of the turbidite section is a distinctive, granitoid-boulder conglomerate a few metres thick. It is similar to the conglomerate which marks the base of the Unuk River Formation further south. This suggests that uplift of the source area began during the Late Upper Triassic and continued into the Lower Jurassic.

3.2 Hazelton Group

In the property, rocks of the Hazelton Group outcrop along the west side of the Unuk Claim Block and in the Coul Claims. The Hazelton Group is divided into three (or four) formations as follows:

top	(Salmon River Formation)
	Mount Dilworth Formation
	Betty Creek Formation
base	Unuk River Formation

The lithology of some intervals in the Betty Creek and Unuk River Formations differ greatly from those at the type localities, suggesting that new formational names might be adopted to describe these different lithological units in this region. As well, the lithology of the Unuk River Formation varies widely from place to place in the property.

3.2.1 Unuk River Formation (= your Jack fm)

Figure 6 (not done yet) shows the variation in stratigraphic section of the Unuk River Formation along the west and northwest sides of the property. At the base of the Unuk River Formation along the west side of the Unuk Anticlinorium is a distinctive, mature, basal conglomerate up to 20 metres thick containing abundant, well rounded cobbles and boulders of volcanic and plutonic rocks. The largest boulders, locally up to 1 metre across, are of a medium grained granodiorite of unknown age and origin. The granodiorite is dissimilar from any known intrusive rocks in the Sulphurets area to the east (Kirkham, pers.comm.), and probably was derived from an unknown western source. The conglomerate also contains scattered limestone pebbles and cobbles. From Lawrence Ridge to the south, it rests conformably to locally unconformably on mafic flows, flow breccias and tuffs of the Stuhini Formation. Upwards, it grades into an interbedded sequence of pebble and granule conglomerate interbedded with coarse to fine, fairly mature sandstone. The whole section becomes finer towards the top.
The conglomerate can be traced from east of John's Peaks, where it is the thickest, to the north end of Lawrence Ridge, where it thins. Just south of Tarn Lake it is only one metre thick and discontinuous. It was not seen in the interval from Tarn Lake to Jack Glacier.

On the southwest side of Jack Glacier, a major unconformity is well exposed between the Stuhini and Hazelton Groups. Turbidites at the top of the Stuhini Formation are truncated at a low to moderate angle by rocks of the Unuk River Formation. Within a metre of the base of the Unuk River Formation are distinctive layers up to several centimetres thick dominated by angular fragments averaging a few centimetres across of the underlying turbidites. Locally a terra rosa (regolith) occurs in the underlying turbidites, suggesting exposure to the atmosphere during uplift and tilting of the Stuhini rocks (Tom Wright, pers. comm.). In the Unuk River Formation within a few metres of the unconformity is a distinctive cobble to locally boulder conglomerate dominated by fragments of felsic tuff, and devoid of fragments of granitoid or limestone. Many rocks on both sides of the unconformity contain moderate to strong, carbonate-hematite alteration (probably related to abundant later, mainly north to northeast trending, irregular felsic dykes averaging 1-3 metres wide).

Higher in the section in the south, the mature, buff coloured sandstone is overlain by a conglomerate/breccia unit dominated by angular to rounded fragments of intermediate volcanic flows with minor ones of limestone and granodiorite. Overlying this unit is a mixed zone of finer intermediate tuffs and fine clastic sediments. Towards the top of this section, rocks become increasingly calcareous, and a few limestone lenses occur. Here are abundant fossils including Weyla clams, belemnites, ammonites, and pelecypods. In the Tarn Creek area, the rocks are tightly folded in the core of a synclinal warp on the west flank of the Unuk River Anticlinorium.

North of Tarn Creek, the section is much thinner. The lower conglomerate-sandstone unit and the overlying conglomerate-breccia unit are absent. Fine intermediate to felsic tuffs overlie mafic to intermediate flows of the Stuhini Group. Higher in the section are calcareous, clastic sediments and thin limestone intervals containing characteristic fossil assemblages as to the south. Near the top of the

section are a few distinctive, commonly graded beds of felsic lapilli to fine tuff interlayered with mudstone and siltstone. The felsic tuff is similar in composition to overlying rocks of the Betty Creek Felsite, and may represent an early stage of that felsic volcanism.

3.2.2 Betty Creek Formation

Some ambiguity exists as to the position of the boundary of the Unuk River and Betty Creek Formations. In this study, it is placed at the base of the major felsic unit on Gord, Felsite, and AP Ridges. Some workers (Kirkham, and Lewis, pers. comm.) have suggested that this felsite unit may be part of the Mount Dilworth Formation. However, they have difficulty in explaining the presence of ~~the Betty Creek~~ Andesite higher in the stratigraphic section to the west, which is similar to Betty Creek Andesite elsewhere.

Like → Well it is!

Regionally, the Betty Creek Felsite is an unusual member of the Betty Creek Formation, and has not been described outside the zone on the west limb of the Unuk River Anticlinorium extending from south of John's Peaks to Jack Creek. As indicated above, thin felsic tuff layers in the upper part of the Unuk River Formation may represent early eruptive precursors to the main felsic event. The main felsic event started with eruption of a distinctive rhyolite welded tuff unit up to a few tens of metres thick. It contains strongly flattened, greyish to brown fiamme up to several cm long, and scattered angular felsite fragments mainly less than 1 cm across in a generally white to pale grey or cream, commonly siliceous rhyolitic matrix. Overlying the welded tuff is a thick, lenticular section of tuff breccia and lapilli tuff, which contains fragments averaging 2-20 cm in size and locally up to 80 cm across of a variety of felsic volcanic and hypabyssal rocks (ranging from rhyolite to dacite) in a variable, pale to dark grey or cream to pink groundmass, commonly of dacitic or rhyodacitic composition. Some of the larger fragments are of the underlying rhyolite welded tuff. The tuff breccia is thickest from just north of Tarn Lake to the toe of Bruce Glacier. In places the groundmass and fragments are conspicuously red from hematite; this indicates that some of the unit may have been exposed to atmospheric oxygen. Thinner, commonly well bedded, finer tuff intervals are minor.

not near Bruce Gl.

Associated with the rhyolite welded tuff are discontinuous lenses of flow-banded rhyolite. Flow-banding commonly is parallel to primary layering in the welded tuff, but elsewhere is widely divergent in orientation. Some flow-banded units contain minor to very abundant spherulites averaging 0.5-1 cm across. Associated with some of these are what appear to be bedded tuffs composed mainly of similar spherulites.

Intrusive into the felsic unit in several localities are sub-volcanic plugs up to a few tens of metres across of massive, aphanitic rhyodacite. These are similar in composition and texture to the Hope Plug (see Section). Because of their spatial relationship to the Betty Creek Felsite, and because fragments of similar rocks occur in the tuff breccias, these intrusions are considered to be coeval with the felsic extrusive rocks.

? tuff-br.

Overlying the Betty Creek Felsite is an interval up to a few hundred metres thick of andesite lapilli tuff, with much less tuff, and minor flows. These rocks are typical of the Betty Creek Formation regionally. Only the tuff intervals are well bedded. Rocks commonly

contain fragments of medium green andesite flow and tuff in a medium to dark green groundmass. Locally, the groundmass has a light to moderate maroon colour, also a typical regional feature of the Betty Creek Formation. The maroon color is dominant locally, as in rocks along the ~~at the~~ contact with the overlying Mount Dilworth Formation on Slide Creek at the north side of the Coul 4 claim.

3.2.3 Mount Dilworth Formation

The Mount Dilworth Formation is exposed on the west limb of the Unuk River Anticlinorium, in the Unuk River Fault Block, and on Alice Lake Ridge. Correlation between areas is tenuous, and based on general stratigraphic and lithological similarities rather than on identification of distinct marker units or fossil or radiometric data.

East of Jonathan and Storie Creeks, the Mount Dilworth Formation is exposed along the base of the ridge as a cliff-forming unit of dacite to rhyodacite tuff and lapilli tuff (Anna Zone). It is altered moderately to strongly to quartz-sericite-(pyrite), and weathered cliffs are stained red-orange by limonite. Pyrite is particularly abundant north of the property above Storie Creek.

In the Unuk River Block, the Mount Dilworth Formation is exposed on Jeff Ridge, where it consists of dacite to rhyodacite and locally rhyolite tuff and lapilli tuff. These rocks commonly contain abundant pyrite and locally contain chalcopyrite, sphalerite, galena, stibnite, and anomalous values in gold up to a few ppm (Jeff Zone). On the west side of the main ridge is a thin zone of rhyolite tuff and lapilli tuff interlayered with mudstone. Associated with this zone are the main anomalous surface values of gold on the Jeff Grid.

West of Unuk River on the east flank of Coulter Ridge is an isolated outcrop up to 10 m across of rhyolite and rhyodacite lapilli tuff. It contains fragments of rhyolite in a dacitic groundmass and is surrounded by argillite and minor intermediate tuff; however, stratigraphic and structural relations in this region are obscured by abundant late diabasic dykes.

West of Coulter Creek, rocks of the Mount Dilworth Formation are exposed on both limbs of the open Alice Lake Anticline. Here the unit is discontinuous, either as a result of original deposition on an irregular terrain, or because of erosion. Stratigraphically beneath it is a distinctive fragmental ~~mudstone~~ containing minor to abundant fragments dominated by felsic volcanic rocks. These rocks have been traced to the north by Roland Bartsch, who equates them with the Mount Dilworth Formation at Eskay Creek (pers.comm.). In the northwest corner of the Coul 1 Claim is a oval body up to 500 metres across of slightly to strongly brecciated dacite/rhyolite. Breccia zones are most intense near the margins of the body, and contain minor to locally moderately abundant pyrite.

3.2.4 Salmon River Formation, Bowser Lake Group

Because of lithological similarities and lack of a distinct contact, these units are treated together. Rocks are dominated by interbedded mudstone and siltstone. In the section at Troy Ridge, the well-known

the Salmon River Formation is characterized by interlayered mudstone and felsic dust tuff ("pyjama beds"); this unit was not seen in the property. At Eskay Creek, the Mount Dilworth Formation is overlain by a lenticular pile of andesite flows, attributed by Alldrick to ~~be of~~ the Salmon River Formation. Such volcanic rocks are rare elsewhere in the Salmon River Formation and were not seen on the property.

On both sides of the Jonathan Creek and Jeff Creek Faults, rocks of the Salmon River Formation occur in contact with and stratigraphically above those of the Mount Dilworth Formation. On the east, the section faces west, but is overturned, dipping 45-60 degrees to the east. West of the creek, the section dips east at from 45-60 degrees. No facing orientations were made on surface on the property; however, Peter Lewis (pers. comm.) found easterly facing beds in rocks of the Salmon River Formation in this block just southwest of John's Peaks. Drill data from Jeff Grid indicate beds facing both east and west, suggesting tight folding (see Section). In Coulter Creek, mudstone and siltstone of the Salmon River and/or Bowser Group are folded tightly about axes trending north-south.

4.0 PROPERTY GEOLOGY - INTRUSIVE ROCKS

Intrusive rocks on the property are divided into the following main types:

1) Pre-Upper Triassic granodiorite boulders in conglomerate
2) Pre-deformation intermediate dykes and sills
3) Hope Plug and similar smaller plugs, dykes, and sills (probably related to Betty Creek Felsite and less probably to the Mount Dilworth Formation)
4) John's Peak Diorite and related(?) diabase, diorite, and gabbro sills, in part brecciated
5) Late felsic dykes

The granodiorite boulders have been described previously.

On the cliff face northeast of Tarn Lake, a sill up to 25 cm wide was boudinaged along foliation in a strongly foliated mudstone interval in rocks of the Unuk River Formation. Elsewhere, a few intermediate dikes and sills have irregular contacts with host rocks of the Stuhini Group and Unuk River Formation, suggesting that they were deformed.

The Hope Plug is an equant body a few hundred metres across which intruded mafic volcanic rocks and turbidite sequences of the upper part of the Stuhini Group and sedimentary rocks of the Unuk River Formation. It is mainly aphanitic, with minor ~~feldspar~~ plagioclase phenocrysts and clusters of phenocrysts. The colour is mainly pale to light green, but irregular patches up to several tens of metres across are medium to dark green and black. Towards the margin is a zone up to a few metres across containing weak, delicate flow banding, mainly parallel to the contact. Along the margin is a zone a few metres wide containing lenses and patches of finely brecciated felsite in a siliceous groundmass and patches of an irregular fine to coarse breccia containing unusual, commonly dark green to black fragments. Near the margins of the body, pyrite is common in the breccia matrix as disseminated grains and replacement patches and in veinlets. In the core of the body are sets of well developed, columnar joints.

Two dykes up to a few metres across of similar composition cut mafic volcanic rocks of the Stuhini Group at the Stibnite Showing just north of Lawrence Peak.

Other small felsite plugs up to a few tens of metres across intrude welded tuff of the Betty Creek formation at the AP Showing, and cut tuff breccia bodies to the northwest near Bruce Glacier. One of the latter intrusions has a well developed contact zone up to 2 metres wide containing unusual fragments of aphanitic felsite in a groundmass of altered felsite. It is similar in part to the contact zone of the Hope Plug. The spatial proximity of these rocks to the Betty Creek Felsite and the inclusion of fragments of similar composition and texture in the upper tuff-breccia of the Betty Creek Felsite suggest a genetic association.

5.Ø PROPERTY GEOLOGY - STRUCTURE

5.1 Structural Elements

5.1.1. Primary Features

Primary features include bedding and facing indicators.

Bedding (So) is well developed in most sedimentary intervals, especially in turbidites. In strongly deformed regions, bedding commonly is transposed parallel to a steeply dipping foliation; these zones are indicated on the geological maps by the symbol, Ø-1, beside the foliation symbol.

Facing indicators are well developed in turbidite intervals, and much more poorly developed elsewhere. They are critical to the understanding of the nature of folding in the tightly folded rocks in the core of the Unuk River Anticlinorium.

1) Graded beds are the most common indicator, almost all graded beds are normally graded. A graded section is present in the lower part of the Unuk River Formation, where boulder and cobble conglomerate beds are overlain by pebble conglomerate beds interlayered with coarse grained arenites, which in turn are overlain by finer grained arenites.

2) Cross beds are present locally in turbidite intervals; these also give current directions.

3) "Ball and pillow" structures, caused by different densities of soft sediments, are present locally in turbidite intervals where arenite beds overlie mudstone.

4) Scour channels and lag deposits are mainly of sandstone and locally contain pebbles or cobbles. They fill erosion channels in finer grained clastic sediments.

5.1.2 Soft-sediment Deformation Features

These are deformation features in sedimentary rocks which have no systematic pattern relative to regional stress fields. In places they have been overprinted by deformational features related to regional stress fields. However, folds formed during such overprinting have no

systematic orientation. Most features of soft-sediment deformation are indicative of ductile deformation, and are indicative of ~~high-energy~~ environments, such as might be ~~produced~~ in tectonically active areas. These features are common in the Unuk River Formation near Tarn Lake.

1) convolute bedding is caused by slumping of beds, which behave like a thin crumpled sheet between more resistant layers. The orientation of the slump indicates slope direction.

2) rip-up clasts, mainly of bedded mudstone in coarser clastic sediments; the orientatuoin of clasts may indicate flow direction.

3) debris flows are up to a few metres thick and contain chaotic folding patterns and large angular blocks. Generally, features are too chaotic to indicate slope directions.

4) minor ~~transform~~ faults locally offset certain layers while not affecting those above or below. They are indicative of high hydrostatic pressure, which allowed brittle deformation to occur even before the sediments were lithified.

5.1.2 Secondary Features

Regional deformation produced broad warping and folding. A generally poorly to moderately developed regional foliation is axial planar to major folds. It produced moderate to strong flattening of clasts. It cuts bedding and offsets it slightly in noses of folds. On limbs of folds, bedding was transformed subparallel to regional foliation. In noses of anticlines in the Unuk River Anticlinorium, bedding was transposed parallel to axial planar foliation.

Lineations generally were developed poorly. Most common are mineral lineations indicating the intersection of bedding and ~~regional~~ foliation. Less common are fold axis lineations marking axes of folds. In places these are subparallel. However, wide diversity in orientation of lineations in different parts of the property suggest that lineations were formed in more than one stage of deformation, and that some early-formed lineations were rotated by later folding or faulting.

5.2 Structure by Regions

5.2.1 Unuk River Anticlinorium

At first glance, this appears to be a simple broad anticlinorium affecting all the Triassic and Jurassic rocks. However, the following features indicate that it is more complex:

1) The core of the anticlinorium is a strongly foliated zone containing at least three and maybe four anticlines and two or three synclines. Noses of anticlines were strongly foliated, and anticlinal closures were not seen. Noses of synclines were preserved, and are well seen on the slopes above East McTagg Creek/Glacier. The zone of strong shear deformation in the core of the anticlinorium extends to the south at least several kilometres into a zone of highly deformed and moderately metamorphosed rocks (Tom Wright, pers.comm.). These rocks may represent the lower part of the Stuhini section or may be Paleozoic.

2) On both limbs of the anticlinorium, beds are overturned moderately to strongly, with dips from 45-70 degrees. Thus the overall shape of the anticlinorium is, as in Figure 7. (not done) like a mushroom

3) To the north, the fold is much simpler and more open. Foliation is weak to absent, and beds appear to wrap around a moderately to steeply north-plunging axis. Numerous block faults have broken the nose of the fold, and minor secondary folds with an east-west orientation are present.

4) Broad warps on the flanks of the main fold have been documented in Hazelton Group rocks near and underlying Bruce Glacier and in Stuhini Group rocks on a north-south ridge south of West McTagg Glacier. In the latter, a prominent lineation plunges northwest at 45 degrees, suggesting that this fold is not associated with the development of the north-plunging Unuk River Anticlinorium.

5) A strong east-west foliation is developed locally in rocks on the ridge south of Gingras Creek. A similar strong east-west foliation is developed in the southeastern corner of the property and further east along Mitchell Glacier (R. Kirkham, pers.comm.).

Data suggest the following structural interpretation. During an early deformation, rocks of the Stuhini Group were tilted, uplifted and ~~probably~~ folded. Evidence for tilting includes the angular unconformity southwest of Jack Glacier and regional unconformities reported elsewhere. Evidence for uplift includes the basal granitoid-boulder conglomerate along the western margin of the Stuhini rocks and the local development of "terra rosa" along the unconformity southwest of Jack Glacier. Evidence for early folding is inconclusive; however, a suggestion of early folding comes from the contrast between strongly folded Stuhini Group rocks in the core of the Unuk River Anticlinorium and the broadly warped rocks of the Hazelton Group to the north.

The wide lateral distribution of the relatively thin Mount Dilworth Formation has lead many authors to conclude that it was deposited on a surface of very low relief, indicating a major erosional period after formation of the Betty Creek Andesite. Workers in the Eskay Creek area suggest an unconformity at the top of the Mount Dilworth formation.

east-west compressional

After deposition of the Salmon River/Bowser Group rocks, broad folding produced the broad arch, north-plunging arch which is part of the Unuk River Anticlinorium. A few major parasitic folds were developed on its limbs, the most prominent of which ~~being~~ that in the Betty Creek Felsite under Bruce Glacier. In this fold, the massive basal welded tuff unit is warped broadly, whereas in tuff-breccia and lapilli tuff units above was developed a moderate to strong axial planar foliation striking 000-030 degrees and dipping 70-80 degrees southeast.

Later(?) deformation in some areas is associated with a steeply dipping, east-west cleavage, and a moderately prominent lineation. South of McTagg West Glacier, a prominent lineation plunges 45-55 degrees northwest, and is developed mainly in the nose of a northwest facing broad warp in bedding in sedimentary rocks of the Stuhini Group.

5.2.2 Unuk River Zone

This block is separated from rocks to the east by the Jonathan and Jeff Creek Faults and from the rocks to the west by an assumed fault along the west side of Unuk River. Rocks in this block are characterized by a stronger foliation than elsewhere in the region (except in the core of the Unuk River Anticlihnorium); foliation strikes north to northwest and dips moderately to the northeast, and is subparallel to bedding. A prominent lineation marking their intersection plunges moderately to the east. The nature and orientation of these structural features is difficult to correlate with deformation features east of Jonathan Creek. As well, the stratigraphic position of rocks in the block is uncertain. The small block between Jeff and Jonathan Faults consists entirely of rocks of the Salmon River Formation/Bowser Group. In it, both bedding and foliation dip moderately to the south, and a prominent lineation marking their intersection plunges gently to the south. This narrow block may have been rotated during late faulting; however, in that model, to reconstruct the blocks to produce a consistent, pre-faulted fabric orientation encounters "room" problems.

5.2.3 Coulter Creek - Alice Ridge Zone

In this zone, rocks appear to be folded about gently plunging, open to isoclinal, north-south fold axes. Deformation is more intense in mudstone and siltstone of the Salmon River Formation/Bowser Group than in underlying rocks of the Hazelton Group. Foliation and lineation are weak, except in the mudstone/siltstone units, where they vary from weak to moderate.

On Alice Ridge, the Mount Dilworth Formation dacite-rhyodacite is exposed on the crest of a broad anticline (Alice Lake Anticline). Directly beneath the felsite is an unusual fragmental mudstone containing minor to abundant coarse tuff to lapilli sized fragments of altered felsite. Westward to the Harrymel Fault in Harrymel Creek, the structure is uncertain.

5.3 Late Faults

5.3.1 Major Faults

The region is divided into three main regions by late faults, many of which have been noted above. Geologists working in the region have not studied these faults in any detail (except the Harrymel Fault to the west of the property). The faults are described from west to east across the property.

The Harrymel Fault is a north-south fault zone which dips steeply to the east, with normal offset exposing rocks lower in the stratigraphic section to the west (Alldrick and Britton).

It is possible that a major north-south fault (Coulter Creek Fault) occurs along and just west of Coulter Creek. North of the property, regional studies show a fault in the creek. In the northern part of the Coul 2 Claim and further north, along Coulter Creek rocks are complexly warped and block faulted, suggesting the presence of a major fault. Early, north-south trending, close to isoclinal folds plunge gently to the north or south. Further south, the creek occupies a bedding plane

contact in uniformly steeply dipping, well bedded mudstone and siltstone of the Salmon River Formation/Bowser Group. It may be that the zone of complex deformation and faulting crosses the region of no outcrop on the slope just west of Coulter Creek.

A prominent linear feature extends north-northeastward from the west side of the Unuk River along a broad creek valley. Outcrop is poor along this zone. This creek marks the approximate western boundary of the zone of strong, moderately easterly to northeasterly dipping foliation in the Unuk River Block. To the west, rocks dip moderately northwards and are foliated only weakly.

The Jeff and Jonathan Faults mark the eastern boundary of the Unuk River Block. They have been described in some detail above.

Just north of Tarn Lake, a major resistant block of Betty Creek Felsite appears to be thrust to the east over rocks of the Unuk River Formation. A small fault dipping 50 degrees west was mapped locally along the lower contact of the felsite against the western end of the Hope Plug. The thickness of the section of the Unuk River Formation is much less in this region than to the south. This might be explained partly by such thrusting, or alternately or partly by the presence of a topographic high in the underlying Stuhini Group rocks. This fault may represent a late stage in the east-west compression which produced the Unuk River Anticlinorium.

The northern extension of the Brucejack Lineament is projected to cross the eastern part of the property in the region of the Johnstone Icefield. A few major faults were mapped along Jack Ridge to the north, and it is possible that one of these is the extension of the Brucejack Lineament. However, the geology to the east is very complex (Kirkham, pers. comm.), and it may be that the lineament does not extend into the property.

Just east and southeast of the property is a series of major thrust blocks which carry rocks of the Stuhini Group eastward and southeastward across strongly altered rocks of the Hazelton Group. These faults probably were formed during the major east-west crustal shortening which accompanied deformation of the Bowser Lake Group rocks in the overlying Bowser Basin.

5.3.2 Smaller Faults

5.3.2.1 General

Numerous smaller faults cut all the blocks; they are exposed best on ridges, where they commonly occupy saddles. Many contain complex carbonate veins and breccia veins which grew as the faults were opening in a tensional regime. These commonly contain fragments up to several cm across of wall rocks, mainly black mudstone. Many have delicate, spheroidal textures, and some have vuggy cores, in part filled by coarse grained calcite. Most are cream-coloured dolomite to ankerite, with minor growth zones of hematite. A few are of light to medium grey calcite. They are most obvious on ridges in the Stuhini Group rocks.

Where faults cut intermediate to mafic volcanic rocks of the Hazelton and Stuhini Groups, ankerite alteration halos are common. Offset on the faults is difficult to determine, but generally is less than a few tens of metres.

Several faults contain prominent slickensides, which generally dip gently. In several faults, carbonate and quartz-(pyrite) veins were emplaced in part before and in part after slickensides were formed.

5.3.2.2 Specific Faults

(Gord) A major shear zone occurs along Anomaly Creek on the east side of Alice Ridge. Associated with it is a prominent geochemical anomaly in arsenic and antimony with minor gold (See Economic Geology).
(Gord) Another major shear occurs on the west side of Alice Lake. This contains a quartz vein with anomalous gold values (See Economic Geology).

A prominent south-dipping fault occurs along the south side of Tarn Glacier, where it cuts and offsets by severalmetres the contact between the Hope Plug and Stuhini Group tuffaceous andesites. Near its east end, a branch extends steeply up the ridge to the south along the contact between the Hope plug and Stuhini mafic volcanic flows, pillowed flows, and tuffs. Further south, this fault disappears, and the contact between the Hope plug and Stuhini group rocks is exposed and is folded moderately.

A fault up to 20 cm wide occurs at the southeast side of the AP Glacier. It strikes about north-south and dips steeply to the east. It contains a quartz vein with abundant disseminated pyrite. Slickensides on the fault and in the vein are parallel to the dip.

A prominent ankerite-quartz alteration zone up to a few metres wide occurs along a steeply dipping northwest-trending fault which cuts Stibnite Ridge. In this zone, mafic volcanic rocks are altered strongly to a light blue-grey rock which elsewhere might be described as felsite.

Northwest of the AP Zone, several faults juxtapose well foliated welded tuff against massive tuff breccia or felsite intrusive rocks. These may be intraformational faults, formed during extrusion of the Betty Creek tuff breccia.

6.0 ECONOMIC GEOLOGY

In this section of the report are documented the relationships between zones of economic interest and local structure and stratigraphy. Details of the deposits and showings are in Part C of the report, which deals with Economic Geology.

6.1 Stuhini Group Rocks

No stratabound deposits of economic interest are present. At the top of the major mafic volcanic unit at or near the top of the Stuhini Group section are abundant veinlets and veins dominated by pyrite and calcite, with minor quartz and secondary copper minerals. These are prominent on Jack Ridge just above Jack Glacier and on the ridge northeast of Tarn Creek.