GEOLOGY AND MINERAL OCCURRENCES OF THE MESS LAKE AREA (104G/7W)

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KEYWORDS: Regional geology, Mess Creek, Schaft Creek, calcalkaline porphyry, Stikine assemblage, Stuhini Group, Mount Edziza Volcanic Complex.

INTRODUCTION

The Schaft Creek project culminates three years of 1:50 000-scale regional mapping in the Stikine-Iskut rivers area. Current mapping completed the west half of Mess Lake map area (104G/7), in which the large-tonnage Schaft Creek porphyry copper-molybdenum-gold deposit is located (Figure 1-9-1); the east half lies within Mount Edziza Provincial Park. Fieldwork was completed in a 5-week season.

Project objectives include provision of an updated 1:50 000-scale geological map with mineral occurrences and metallotects, determination of the timing of mineralization at the Schaft Creek porphyry copper-molybdenum deposit through a U-Pb zircon date, and ultimately a mineral potential map of the area west of Mount Edziza Park. Preliminary accomplishments and geological highlights include the recognition of a Lower Permian calcalkaline volcanic succession and a middle Pennsylvanian basaltic volcanic succession. The age of both packages is indicated by intercalations of fusulinid limestone. The Forrest Kerr pluton, now known to be as old as Late Devonian (Drobe *et al.*, 1992) was traced to the north edge of the map area. In addition, the thick granite and quartz-bearing conglomerate, interpreted to be Permian by Logan *et al.* (1992a), has been reassigned an Early Jurassic age as originally suggested by Souther (1972).

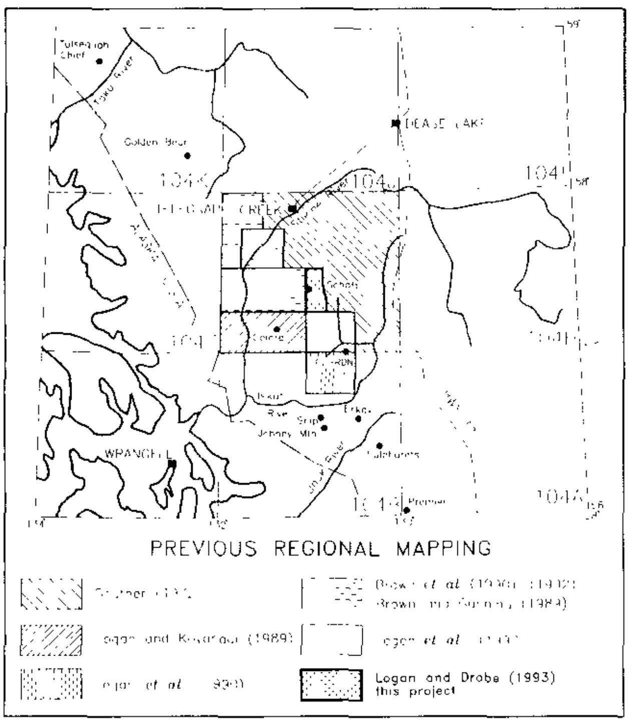

Figure 1-9-1. Location map showing previous and current field areas for Iskut North (Logan *et al.*) and Stikine (Brown *et al.*) projects.

The map area straddles the physiographic boundary between the rugged Coast Mountains and Tahltan Highlands of the Stikine Plateau. East of Mess Creek, the Tahltan Highlands are dominated by the volcanic shield of Mount Edziza (Souther, 1972). West of Mess Creek, there is a significant increase in topographic relief and the summits are more rugged and underlain by Mesozoic volcanics of the Stuhini Group. Mess Creek, which flows north within a fault-controlled valley, contains tufa deposits and actively discharging hot springs.

REGIONAL GEOLOGY AND PREVIOUS WORK

The map area contains some of the oldest and youngest known rocks of Stikinia. Relatively few intervals are missing from Early Devonian to Recent time. Faults divide the area into four dominant lithotectonic packages. From east to west these are Devonian to Mississippian, Early Permian, Pennsylvanian and older, and Triassic to Jurassic. Volcanic outliers of the Pleistocene and Recent Mount Edziza Volcanic Complex overly these packages as far west as Mess Creek.

Geology south of the map area is described by Logan *et al.* (1989, 1990a, b, 1992a, b), Logan and Koyanagi (1989) and that to the immediate west by Brown and Gunning (1989a, b) (Figure 1-9-1). Regional studies include 1:250 000-scale mapping of the Telegraph Creek sheet (Souther, 1972) and detailed studies of the Mount Edziza Volcanic Complex (Souther and Symons, 1974; Souther, 1970, 1988).

STRATIGRAPHY

The geology of the Mess Lake area is illustrated in Figure 1-9-2 with only minor simplifications. Figure 1-9-3 summarizes the stratigraphic and structural relationships in two schematic cross-sections across the north and south parts of the map area.

STIKINE ASSEMBLAGE

Monger (1977) defined the Stikine assemblage to include all late Paleozoic rocks peripheral to the Bowser Basin. These rocks form the basement of Stikinia and record its history before and after accretion to the North American continent. The Early Devonian through Carboniferous rocks of the Mess Lake area record more than 100 million years of

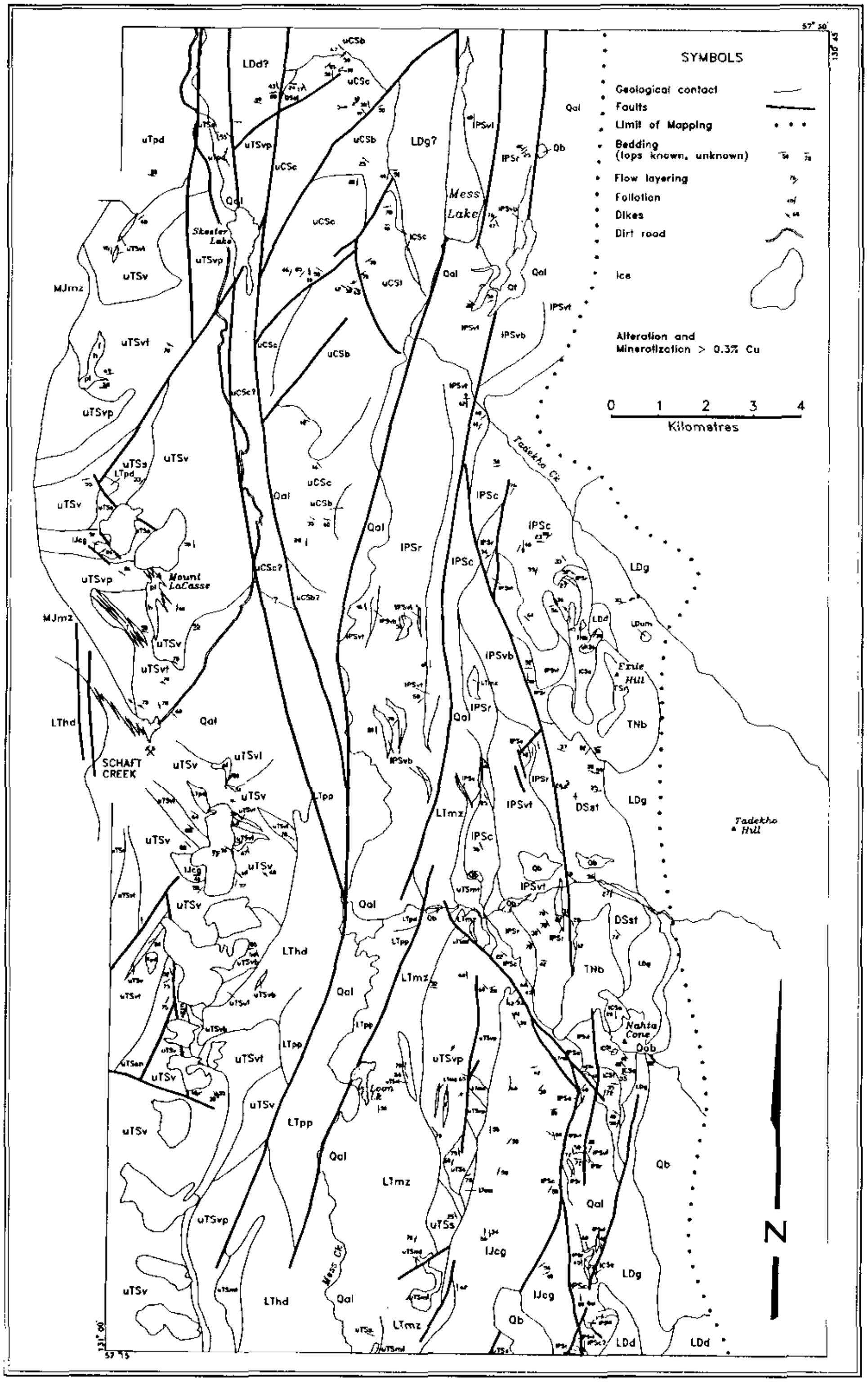

Figure 1-9-2. Simplified geology of the Mess Lake area. *See* facing page for legend.

LEGEND

LAYERED ROCKS

QUATERNARY
PEISTOCENE AND RECENT

- **Qt** — *hot-spring deposit, tufa*

BIG RAVEN FORMATION

- **Qob** — *olivine basalt, pyroclastic cone and tephra, lava flow*
- **Qal** — *unconsolidated glacial till and poorly sorted alluvium*

ARCTIC LAKE FORMATION

- **Qb** — *olivine-plagioclase-augite basalt, tuff breccia and flow; intra-flow fluvial and glacial deposits*

TERTIARY
PLIOCENE

SPECTRUM FORMATION

- **TSr** — *leucocratic peralkaline rhyolite*

NIDO FORMATION - KOUNUGU MEMBER

- **TNb** — *aphyric and olivine-phyric basalt, subaerial flows, intercalated fluvial gravel*

UPPER CRETACEOUS TO TERTIARY

SUSTUT GROUP

- **uKSs** — *chert-pebble conglomerate, quartzose sandstone and siltstone*

LOWER TO MIDDLE JURASSIC

- **lJcg** — *cobble to boulder conglomerate and coarse sandstone, quartz-rich, well-bedded; lower section of quartz-feldspar crystal-lithic tuff*

UPPER TRIASSIC

STUHINI GROUP

- **uTSs** — *well-bedded green dust tuff, tuffaceous siltstone-sandstone turbidites, minor limestone and conglomerate*
- **uTSv** — *augite-phyric, plagioclase-phyric and aphyric basaltic andesite flows and equivalent subvolcanic intrusives*
- **uTSvt** — *massive to weakly stratified, polylithic lapilli tuff, bedded epiclastics*
- **uTSvp** — *plagioclase phyric basalt flows and subvolcanic gabbro*
- **uTSmt** — *mafic tuff and lesser flows*

STIKINE ASSEMBLAGE

LOWER PERMIAN

- **lPSc** — *dark grey and buff, medium-bedded to massive fossiliferous carbonate, thin-bedded sections contain intercalated tuff and chert*
- **lPSr** — *flow-layered and spherulitic rhyolite lava; quartz-feldspar-phyric rhyolite lava, autobreccia, ashflow tuffs*
- **lPSvt** — *feldspar phyric lapilli and crystal tuff, interbeds of limestone near top*
- **lPSvb** — *plagioclase and pyroxene-phyric andesite flows, basalt flows and related breccias*

UPPER CARBONIFEROUS

- **uCSc** — *grey, thin-bedded, fetid and dolomitic limestone, maroon and green lapilli tuff and cherty siltstone*
- **uCSb** — *amygdaloidal green, grey and maroon basalt, aphyric to sparsely plagioclase phyric*

LOWER CARBONIFEROUS

- **lCSt** — *tuffaceous wacke, siltstone, sandstone and volcanic conglomerate*
- **lCSc** — *grey, medium-bedded to massive, bioclastic limestone; buff dolomitic and ferruginous units*

LOWER DEVONIAN

- **DSst** — *green and red-purple schistose tuff and minor flow , thin interbeds recrystallized grey and buff limestone (DSc)*
- **DSqs** — *chlorite schist, quartz sericite schist*

INTRUSIVE ROCKS

- **DIKES** — *(a) aphyric andesite and basalt; (pp) mafic plagioclase ± pyroxene porphyry; (f) felsic ± quartz eyes; (h) hornblende porphyritic diorite; (pl) plagioclase porphyry*

MIDDLE JURASSIC

YEHINIKO PLUTON

- **MJmz** — *pink equigranular hornblende-biotite monzonite, monzodiorite*

LATE TRIASSIC OR YOUNGER

- **LTpd** — *medium-grained equigranular augite diorite and gabbro*
- **LTpp** — *grey to green, stubby-plagioclase porphyritic hornblende pyroxene diorite*
- **LTmz** — *salmon-orange crowded plagioclase hornblende monzonite porphyry, trachytic and equigranular phases*

HICKMAN PLUTON

- **LThd** — *equigranular, pink and grey, medium-grained hornblende monzonite and diorite*

LATE DEVONIAN

FORREST KERR PLUTON

- **LDg** — *biotite granite to tonalite*
- **LDd** — *hornblende diorite, quartz diorite*
- **LDum** — *coarse-grained gabbro, hornblendite, clinopyroxenite etc.*

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island arc volcanism and carbonate accumulation interrupted by tectonism and uplift. Calcalkaline volcanism, in part subaerial, was followed by carbonate deposition during the Early Permian interval (Brown *et al.*, 1991).

DEVONIAN OR OLDER (DSst, DSqs)

Penetratively foliated, polydeformed intermediate to mafic volcanic rocks underlie a narrow belt along the eastern margin of the area mapped (Figure 1-9-3). These rocks crop out sparsely between Nahta Cone and Exile Hill where they are overlain by Tertiary lava flows. Contact relationships with Early Carboniferous and younger rocks are either faulted or hidden beneath overburden. To the east, Early Devonian hornblende diorite and biotite granodiorite (Units **LDd** and **LDg**) intrude the volcanic rocks (Figure 1-9-3b).

Purple and green tuffs, aphyric to plagioclase-phyric flows and rare silicified, ankeritic carbonate horizons (**DSst**) are exposed in a west-flowing creek 3 kilometres north of Nahta Cone. Farther north are plagioclase-phyric volcanic rocks, including lapilli ash flow tuff (**DSst**) and intermixed phyllite, chlorite and quartz sericite schists (**DSqs**). These volcanic rocks are variably foliated and crenulated and distinguished from younger rocks in the map area by their degree of deformation.

LOWER CARBONIFEROUS (lCSt, lCSc)

A distinctive orange-weathering belt of limestone extends southward 7 kilometres from Tadekho Creek to just north of Arctic Lake in the Forrest Kerr map area (Logan *et al.*, 1992a). The belt is split from the southern edge of the map area to Nahta Cone (Figure 1-9-2). Fossils indicate that the eastern branch is Lower Carboniferous and the western Lower Permian (E.W. Bamber, personal communication, 1992). Small patchy outcrops of Lower to mid-Carboniferous limestone (**lCSc**) can be traced 6 kilometres north from the map border to Nahta Cone, where it rests conformably on medium-grained pink granite of the Late Devonian Forrest Kerr pluton (Figure 1-9-3b). The base of the limestone is limonitic and contains quartz grains and granitic grit, although no basal conglomerate was observed. Elsewhere, the limestone overlies penetratively foliated mafic volcanic rocks, tuff and chlorite and sericite schist of Devonian and older age. The contact relationship is not clear.

At its northmost extent, the limestone is unconformably overlain by Pliocene columnar basalts and Pleistocene and Recent tephra and basalt of Nahta Cone (Plate 1-9-1). Preliminary fossil identifications from the limestone give early mid-Carboniferous (Serpukhovian) ages (E.W. Bamber, personal communication, 1992).

Well-bedded, pale green to khaki greywacke and cherty volcanic siltstone of Unit **lCSt** overly limestone in apparent conformity south of Nahta Cone and in a small exposure north of Exile Hill (Figure 1-9-3b). Macrofossils collected from these sediments are non-diagnostic. West of Mess Creek, similar limestone and volcaniclastics correlate on the basis of lithology and stratigraphy. Fine-grained aphyric lapillistone tuff, ash and dust tuff grading to thinly interbedded sandstone and siltstone of Unit **lCSt** crop out along the top and extending down the eastern side of the plateau west of Mess Lake. Limestone (**lCSc**) is interbedded within this volcaniclastic sequence, but the thickest accumulation parallels the top of the Mess Lake pluton. This succession forms the footwall of a faulted contact with Late Carboniferous mafic volcanic rocks.

UPPER CARBONIFEROUS (UCSB, UCSC)

Upper Carboniferous rocks are confined to a narrow, north-trending, high plateau west of Mess Creek, in the northwest corner of the map area between Mess and Skeeter lakes (Figure 1-9-2). They are separated from Upper Triassic rocks to the west and Lower Permian rocks to the east by northerly trending regional faults.

A succession consisting of polydeformed, structurally thickened limestone, chert and siliceous tuff (**uCSc**) is exposed east of Skeeter Lake and extends to the top of the plateau. It structurally overlies a lower package of massive, amygdaloidal basalt flows and tuffs (**uCSb**) (Figure 1-9-3a). These rocks are in fault contact with Lower Car-

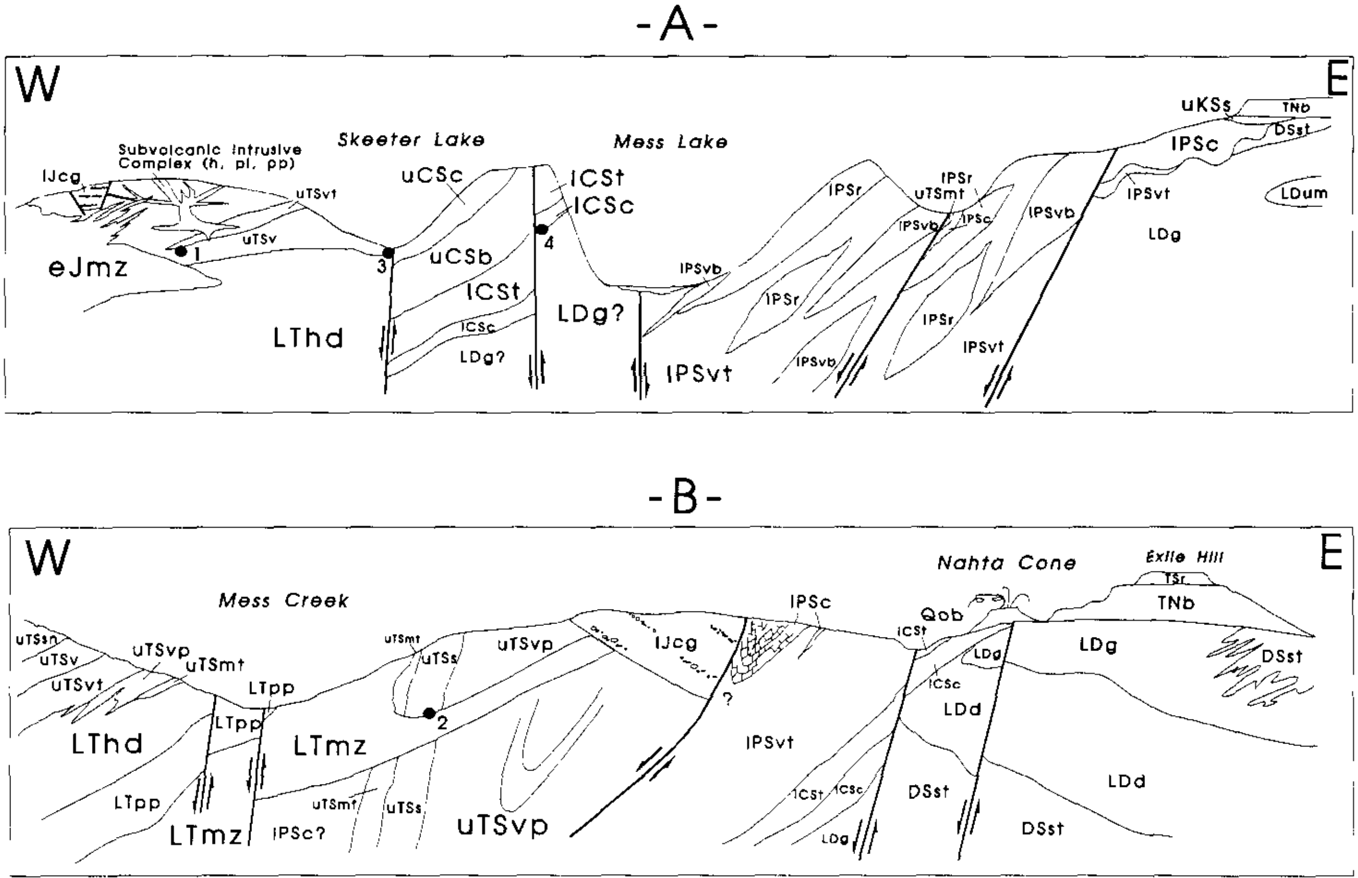

Figure 1-9-3. Schematic representation showing stratigraphic relationships of the various units across the northern (3a) and southern (3b) part of the Mess Lake field area. Mineral occcurrences are shown in their respective stratigraphic positions. *See* text and Figure 1-9-2 for description of units. Numbers correspond to mineral occurrences; 1 = Schaft Creek; 2 = Run, Mix, Run North; 3 = BB 38 and 57; 4 = Cot & Bull.

Plate 1-9-1. Tufa terraces east of Mess Creek, near the south end of Mess Lake.

boniferous volcanic wacke, tuff and limestone. The upper unit of limestone, tuff and cherty sediments has accommodated much of the deformation. At the top of the volcanic package are maroon basaltic tuff and interbedded limestone containing Pennsylvanian (Kasimovian to Gzhelian) fusulinacean foraminifers (E.W. Bamber, personal communication, 1992).

LOWER PERMIAN (lPSvb, lPSvt, lPSr, lPSc)

Lower Permian rocks underlie a fault-repeated, north-trending belt 4 to 5 kilometres wide east of Mess Creek and extending south to the boundary of the map (Figure 1-9-2). Medium-bedded Lower Permian packstones form the uppermost unit and are underlain in depositional conformity by a characteristically maroon, in part subaerial, calc-alkaline volcanic succession (Figure 1-9-3a, b). Interbedded limestone horizons containing abundant Wolfcampian fusulinacean foraminifers crop out near the top of the volcanic package (E.W. Bamber, personal communication, 1992).

A moderately west-dipping, fault-duplicated section of Lower Permian volcanics is exposed 3 kilometres west of Exile Hill. The western section is 200 metres thick and forms a dip slope down to Mess Creek. Aphyric purple and green amygdaloidal basalt, plagioclase and pyroxene-phyric andesite breccia flows and associated volcaniclastics form what appears to be the lowest unit (**lPSvb**), but also occur at various levels within this section (Figure 1-9-3a). Well-bedded, feldspar-phyric intermediate and felsic tuffs and epiclastic rocks comprise the characteristically pale maroon weathering medial unit (**lPSvt**). Interbedded quartz-bearing polylithic epiclastic rocks and rare accretionary lapilli tuffs and ash-flow tuffs record contemporaneous submarine and subaerial depositional environments. The uppermost volcanic unit (**lPSr**) consists of mauve to brown flow-layered and spherulitic rhyolite, quartz-feldspar-phyric rhyolite flows, autobreccia and ash-flow tuffs. These felsic rocks are resistant and form most of the prominent ridges and the dip slope east of Mess Creek.

Medium-bedded to massive Lower Permian packstone (**lPSc**) forms prominent knobs and discontinuous ridges extending as far north as Tadekho Creek. It overlies epiclastic rocks of Unit **lPSvt** and flow layered rhyolite of Unit **lPSr**, in apparent conformity, 6 kilometres south and 2 kilometres northwest of Nahta Cone, respectively. Thin-bedded limestone contains an abundant Lower Permian fauna of rugose and tabulate corals, productoid brachiopods, pelecypods, bryozoa and fusulinacean foraminifers.

UPPER TRIASSIC STUHINI GROUP (uTSmt, uTSvp, uTSvt, uTSv, uTSs)

Volcanic rocks of the Stuhini Group underlie Mount LaCasse and most of the rugged mountainous area west of Mess Creek. They also crop out in a narrow north-trending belt east of Mess Creek, where they are less well exposed

(Figure 1-9-2). They lie unconformably on Lower Permian limestone 3 kilometres northwest of Nahta Cone. They are unconformably overlain by Lower Jurassic conglomerate southwest of Nahta Cone and in two localities west of Mess Creek (Figure 1-9-3a, b). They are truncated on both east and west sides by several large intrusions.

West of Mess Creek, Upper Triassic rocks are divided into five volcanic and one sedimentary unit (Figure 1-9-3b). The lowermost unit is green-blue, recessive weathering, mafic lapilli tuff with minor flows (**uTSmt**). The scoriaceous lapilli are altered to serpentine, talc and chlorite. East of Mess Creek, Unit **uTSmt** overlies Lower Permian carbonate of Unit **lPSc** in two areas; the contact in one is partly faulted. Volcanic rocks of Unit **uTSvp** were not observed to directly overlie Unit **uTSmt**, but they usually crop out nearby. Dark grey, massive, plagioclase-phyric basalt flows and related similarly textured intrusive rocks crop out south of the Schaft Creek porphyry copper deposit. Contacts with other units are poorly exposed, except where Unit **uTSvp** is intruded by Unit **LThd**. Tuffs of Unit **uTSvt** were observed to overlie these basaltic rocks in only one place. Unit **uTSvt** comprises massive to weakly stratified, polylithic, grey to mauve lapilli tuff and crystal tuff that form thick sections underlying the east-facing slope above Mess Creek. Both plagioclase and augite crystals are common, although augite is generally less than 5 per cent of the rock. Measurable bedding attitudes are rare; the few measured indicate steep dips. The thickest Upper Triassic unit comprises augite-phyric, plagioclase-phyric, augite and plagioclase-phyric, and aphyric basaltic andesite flows (**uTSv**). It extends the full length of the western edge of the map area and hosts the Schaft Creek deposit. Subvolcanic intrusive rocks are difficult to distinguish and separate from the extrusive rocks and are included with them. Tuffs and flows occur subequally and vary in colour from maroon to green; it is common for purple tuff to be interbedded with green tuff. The basaltic andesite is pillowed for 3 kilometres both northeast and southeast of Schaft Creek. All bedding attitudes of intercalated tuffs observed were steeply inclined to the northeast and southwest. Locally the unit is very likely tightly folded, but the lack of good stratification makes the extent of this difficult to ascertain. Unit **uTSs** comprises about 150 metres of well-bedded green dust tuff, tuffaceous siltstone-sandstone and wackes which crop out on the eastern flank of Mount LaCasse, 4 kilometres northeast of the Schaft Creek deposit. Near its western margin, the well-bedded section thins considerably where it is faulted against Unit **uTSv**. The tuffs also apparently thin to the northeast, limiting their usefulness as a marker unit. Steeply dipping, tightly folded sediments consisting of volcanic conglomerate, interbedded sandstone and siltstone, pyroxene crystal sandstone and limy siltstone (Unit **uTSs**) are exposed about 4 kilometres south of the Schaft Creek deposit. A thin maroon quartz and limestone-bearing volcaniclastic unit (possibly Unit **lJcg**) may overlie these sediments conformably but is faulted against pyroxene-phyric volcanics of Unit **uTSv** farther east. Fossils from thin interbedded siltstone, sandstone and conglomerate are identified as Upper Triassic (Norian; E.T. Tozer, personal communication, 1992).

East of Mess Creek, Upper Triassic rocks are limited to units **uTSmt**, **uTSvp** and **uTSs** (Figure 1-9-3b). Unit **uTSmt** is highly visible in creek exposures where alteration and weathering have produced characteristic dun to bluish green hues. It is intruded along its western limit by the Loon Lake stock (Unit **LTmz**) and may be overlain by silicified dust tuff and turbiditic siltstone of Unit **uTSs**, as it is west of Mess Creek on the More Creek sheet (Logan *et al.*, 1992a, b). Massive tuffs and flows of Unit **uTSvp** include associated subvolcanic intrusive rocks which could not be mapped separately. Both are predominantly plagioclase phyric with lesser pyroxene. Pillowed and breccia flow textures occur locally in the massive sequence of plagioclase-phyric basaltic andesite. The unit is unconformably overlain by Lower Jurassic conglomerate.

Lower to Middle Jurassic (lJcg)

West of Mess Creek, Lower to Middle Jurassic rocks rest with angular unconformity on volcanics of the Upper Triassic Stuhini Group (Figure 1-9-2). East of the Schaft Creek porphyry deposit, on Mount LaCasse, the Jurassic unit comprises conglomerate with equal proportions of well-rounded crowded plagioclase porphyritic andesite and aphyric basalt clasts, interbedded with coarse sandstone containing high proportions of quartz and potassium feldspar. The conglomerate overlies propylitically altered pyroxene volcanics. The nature of the contact is uncertain, but the conglomerate appears to occupy a fault-bounded graben (Figure 1-9-3a). The conglomerate itself is pervasively epidotized (due in part to its permeability). Alteration is probably related to dike swarms associated with the Middle Jurassic Yehiniko pluton.

Moderately south-dipping Jurassic conglomerates rest unconformably on steeply dipping Upper Triassic pyroxene-phyric flows and volcaniclastics in a second exposure 3 kilometres south of the Schaft Creek deposit (Figure 1-9-2). The section comprises 90 metres of quartz-bearing polymictic volcanic conglomerate above a lower quartz and feldspar crystal tuff layer 20 metres thick. The sediments are well-bedded granule or weakly stratified to massive boulder conglomerates and lesser sandstones. Clasts are generally subangular, purple, maroon and green plagioclase and/or pyroxene-phyric andesite. Epidotized clasts are common and clasts of quartz feldspar crystal tuffs increase in abundance down section. The volcanic lower zone is a pale maroon, pink-weathering feldspar and quartz-eye crystal-lapilli tuff. Upper and lower contacts are gradational and therefore conformable with the conglomerate.

East of Mess Creek, the conglomerates outcrop in a belt 2 to 2.5 kilometres wide belt extending north from Arctic Lake to Nahta Cone (Figure 1-9-2). At the northern end of this exposure, they overlie volcanic rocks of the Stuhini Group with structural conformity, but farther south they unconformably overlie Late Triassic plagioclase hornblende porphyritic diorite (**LTmz**). The conglomerate is at least 250 metres thick. In general, the lowermost sections are maroon, well-bedded, immature, volcanic-derived conglomerate. In places they are graded and consist entirely of maroon plagioclase-phyric andesite clasts in a plagioclase-rich groundmass. Up section, quartz and potassium feldspar grains and granite clasts appear then increase in abundance. Layers of coarse carbonate boulders are prominent within the unit. The 4 to 5-metre well-rounded boulders are Mesozoic reefoid limestone. Rare interbedded limestone and sandstone lenses have been sampled for radiolaria.

Upper Cretaceous to Tertiary Sustut Group

Small isolated remnants of Sustut Group sediments (Unit **uKSs**) are preserved on Exile Hill and north of Nagha Creek (Souther, 1988). On Exile Hill, they are well-bedded, pale green weathering and friable quartzose sandstone and polylithic chert-granule conglomerate that rest unconformably on Late Devonian diorite of Unit **LDd** (Figures 1-9-2 and 1-9-3a). The sediments are limonitic, and thoroughly fractured and veined by calcite. Granitic, aphyric volcanic, chert and quartz clasts comprise roughly equal proportions of the granule conglomerate.

Pliocene – Nido (TNb) and Spectrum (TSr) Formations

Subaerial flows of aphyric and olivine-phyric basalt with intercalated fluvial gravel of the Nido Formation (**TNb**) and peralkaline rhyolite flows of the Spectrum Formation (**TSr**) underlie the Arctic Lake plateau and Quaternary members of the Mount Edziza Volcanic Complex on the eastern border of the map area (Figure 1-9-2). These Pliocene rocks were not specifically examined because they were mapped by Souther (1988) at a scale of 1:50 000. The Nido Formation unconformably overlies Paleozoic carbonate, intrusive and volcanic rocks and also Upper Cretaceous sedimentary rocks (Figure 1-9-3a, b). It is overlain by the Spectrum Formation. Flows in both formations are essentially flat lying. At one locality, an intraflow cobble conglomerate is exposed between flows of the Nido Formation.

Quaternary

ARCTIC LAKE FORMATION (Qb)

Basalt flows of the Arctic Lake Formation (**Qb**) form erosional outliers east of Mess Creek (Figure 1-9-2). Most are exposed at elevations above 1000 metres (3500 feet), but one flow crops out on the floor of Mess Creek valley. A whole rock K-Ar date of 0.45 ± 0.07 Ma was obtained from flows at the head of More Creek. Unit **Qb** is characterized by flat to gently inclined, brown to grey weathering, thick, usually vesicular beds of plagioclase, augite and olivine-phyric basalt.

BIG RAVEN FORMATION (Qob)

The youngest consolidated unit in the map area consists of olivine basalt flows of the Big Raven Formation (Unit **Qob**) which form Nahta Cone (Figures 1-9-2 and 1-9-3b). The cone is approximately 70 metres high and consists mainly of black and brick-red scoria blocks. Nahta Cone was breached on its east side and at least two highly fluid lavas flowed to the north along a drainage where they are still preserved. Levees of flow breccia mark the path of the flows down the creek. The cone is situated on the contact between Lower Devonian volcanic rocks of Unit **lCSt** and granitic rocks of Unit **LDg**. A V-shaped apron of lapilli-sized tephra covers these units for a distance of about 700 metres north and 500 metres west of the main cone. The apron provides evidence that the cone erupted on two occasions with differing wind directions. Souther (1970) carbon dated the flows at 1340 years b.p.

HOTSPRING DEPOSITS (Qt)

Hotspring deposits of tufa (Unit **Qt**) occupy an elongate area of about 50 hectares southeast of Mess Lake (Plate 1-9-1). The hotsprings are located along north-trending faults. They are discharging and depositing tufa into a connected series of poorly drained flat-bottomed valleys. Water percolating in the active springs is below body temperature. Most of the deposits are of the low-hill, terraced type, but six small circular cones 1 to 4 metres high and a hill of travertine up to 10 metres high are also present. Many of the tufa terraces have raised pressure ridges presumably reflecting recent fault movement. The ridges have relief on the order of 10 to 40 centimetres and lengths on the order of 50 to100 metres. According to a local trapper, new ridges appear each year, suggesting the faults are still active.

INTRUSIVE ROCKS

Three intrusive episodes are recognized in the Mess Lake area: Late Devonian, Late Triassic or younger, and Middle Jurassic. These correspond in part with episodes described by Anderson and Bevier, (1990); Holbek (1988) and Logan *et al.*, (1990a, 1992a).

Late Devonian

Tonalite, granodiorite, diorite and hornblendite crop out along the eastern margin of the map area (Figure 1-9-2). These rocks are the northward extension of the Late Devonian Forrest Kerr pluton that is exposed around Arctic Lake in the More Creek map area (Logan *et al.*, 1992b). Outcrop of the intrusion extends north as far as Talekho Creek, where the pluton is covered by Lower Carboniferous and Lower Permian limestone and volcanic rocks and Tertiary lava flows. Tertiary and Recent lava flows also cover the eastern edge of the pluton. Along the western edge, it is faulted against Lower Permian volcanic rocks and is locally unconformably overlain by Lower Carboniferous carbonate (Figure 1-9-3b).

As to the south (Logan *et al.*, 1990a, 1992a), the pluton comprises three phases: a granitic phase of coarse-grained biotite tonalite, granite and granodiorite (**LDg**), chloritized hornblende diorite (**LDd**) and minor hornblendite/gabbro (**LDum**). Most of the rock has an equigranular texture. Weakly foliated and passively folded gneissic textures occur close to intrusive contacts and phase boundaries within the intrusion. The pluton intrudes penetratively foliated, schistose metatuffs of Unit **DSst**.

Pink, coarse-grained, equigranular granite west of Mess Lake resembles rocks of the Forrest Kerr pluton, but has an unclear relationship with overlying carbonate of probable Early Carboniferous age. The Mess Lake body crops out only on the east side of the ridge between Skeeter and Mess lakes and, therefore, presumably has a moderate to steep westerly dip (Figure 1-9-2 and 1-9-3a). The granite, limestone and tuffaceous wacke (**lCSc** and **lCSt**) are cut by a north-trending west-dipping diorite dike swarm. From a distance this gives the cliffs a bedded appearance. The contact between the intrusive and the limestone strikes north-northwest and dips moderately southwest.

LATE TRIASSIC OR YOUNGER

HICKMAN PLUTON

A medium to fine-grained, pink or grey elongate stock of monzonite to diorite (**LTHd**) is exposed 10 kilometres south of the Schaft Creek deposit (Figure 1-9-2). It crops out on the east-facing slope above Mess Creek and is probably an eastern extension of the Hickman pluton. Along its western margin numerous aplitic dikes extend from the main stock into Upper Triassic volcanic rocks of the Stuhini Group (Unit **uTSv**). The eastern contact is more problematic. The stock is monzonite near the top (i.e., western margin) where it intrudes Upper Triassic rocks, but grades eastward and downward into hornblende diorite, commonly with occurrences of dark grey hornblendite. To the north, it appears to be faulted against grey plagioclase-porphyritic diorite of unkown age. It is possible that the plagioclase porphyry is a border phase of the equigranular stock or plagioclase porphyry of Unit **LTmz**.

The monzonite portion of the stock is pink and equigranular with up to 15 per cent oxidized hornblende. Where the percentage of hornblende is higher, pink, fine-grained, equigranular dikes to about 30 centimetres wide are common. The mafic content of the stock increases until the rock is fine to coarse-grained hornblendite, with hornblende crystals up to a centimetre in length. The crystals are mostly weakly chloritized, though vitreous hornblende is present. Narrow carbonate-epidote and zeolite veinlets are a common alteration feature.

UNIT LTmz – LOON LAKE STOCK

A north-trending hypabyssal stock of plagioclase hornblende monzonite porphyry (**LTmz**) forms the eastern slope above Mess Creek (Figure 1-9-2). On its eastern side it intrudes Upper Triassic sediments and volcanic rocks of Units **uTSvp** and **uTSs** and, farther north, Lower Permian rocks. The intrusion is unconformably overlain by Lower Jurassic conglomerate of Unit **lJcg** in a creek exposure, about 1.5 kilometres north of the south boundary of the map sheet. The western limit of the Loon Lake stock appears to be faulted against intrusive Unit **LTpp** but the contact may be in part intrusive (Figure 1-9-3b).

The typical texture of the Loon Lake stock is crowded porphyry with 20 to 40 per cent euhedral plagioclase laths to 7 millimetres in length and 0 to 10 per cent hornblende to 3 millimetres in length. The rock is mostly salmon pink to mauve grey. Common variations in the texture include darker grey, less crowded plagioclase porphyry and fine to medium-grained, equigranular grey diorite.

UNIT LTpp

Hypabyssal plagioclase diorite, not unlike the monzonitic Loon Lake stock, crops out along the lower slopes of Mess Creek valley, west of the creek between the Loon Lake stock and intrusive unit **LTHd** (Figure 1-9-2). It was mapped as a separate body, but may be a border phase or related to the Loon Lake stock. The diorite is typically pale green and contains stubby plagioclase phenocrysts to 4 millimetres in length and rare chloritic hornblende or pyroxene.

UNIT LTpd

Plugs of pyroxene diorite crop out in several areas west of Mess Creek (Figure 1-9-2). About 5 kilometres south of the Schaft Creek deposit, a small plug intrudes Upper Triassic sediments. About 2 kilometres south of the deposit, and also about 5 kilometres north of the deposit, similar plugs intrude Upper Triassic volcanic rocks. A similar, larger stock intrudes Upper Triassic volcanic rocks in the northwest corner of the map area.

The plugs are mainly medium-grained, green-grey augite plagioclase diorite. They are generally associated with plagioclase-phyric and coarse pyroxene-phyric dikes and are probably related to them.

YEHINIKO PLUTON (MJmz)

Middle Jurassic monzonite of the Yehiniko pluton intrudes volcanic rocks of the Stuhini Group east of Schaft Creek and north of the Schaft Creek deposit. Most of the contact is gradational and consists of numerous aplite and/or rhyolite apophyses in the country rock (Figures 1-9-2 and 1-9-3a). In places the contact is a simple curviplanar surface. Several small outcrops of the intrusion on the north edge of the Schaft Creek deposit are mineralized together with adjacent volcanic rocks. The southern contact with the Late Triassic Hickman batholith is covered by overburden.

The main phase of the Yehiniko pluton is pink, medium to coarse-grained biotite granite (Brown and Gunning, 1989a). Near its contacts with Upper Triassic volcanic rocks, the texture is finer, more fractured and the colour is grey to orange. Within the Schaft Creek deposit, the intrusion is white, argillically altered, equigranular monzonite to quartz monzonite. North of the deposit, the apophyses of the intrusion are aphanitic to fine-grained, flow-layered pink rhyolite dikes and sills of quartz-eye feldspar porphyry that are possibly younger. These alter the country rock locally.

DIKES

West of Mess Creek, at least four distinct dike and/or sill suites are recognized within the Upper Triassic Stuhini Group. Most are 1 to 10 metres wide. Plagioclase-phyric dikes (**pl**) are the most common. They typically have 5 to 10 per cent opaque, pale green plagioclase crystals averaging 2 to 6 millimetres in length. Pyroxene diorite dikes (**pp**) have textures very similar to those of extrusive rocks within the Stuhini Group and are probably in part coeval with them. In the larger dikes, plagioclase averages 2 to 4 millimetres, augite 5 to 10 millimetres, and the groundmass is finely crystalline rather than aphanitic, as it is in the equivalent extrusive rocks. Hornblende-porphyritic diorite (**h**) is less common and forms irregular bodies (plugs or small dike/sill complexes), mainly north of the Schaft Creek deposit. Vitreous hornblende to 10 per cent and averaging 3 to 10 millimetres long forms glomerocrysts in a grey, aphyric vitreous or sparsely feldspar-phyric groundmass. The age relationships of these dikes is not known. The felsic aphyric and quartz-feldspar-phyric apophyses (**f**) of the Yehiniko pluton cut them. The youngest dikes are aphyric andesite and basalt. These are typically green to grey in colour, average less than 3 metres wide, and are commonly amygdaloidal near the margins. They postdate mineralization at the Schaft Creek deposit.

STRUCTURE

FOLDS

Lower Devonian rocks of Unit **DSst** are penetratively foliated and schistose. The foliation dips gently to the west and is folded isoclinally about northwest-trending axes. Folds are typically recumbant and northeast verging. Macrofolds are overprinted by nonpenetrative and penetrative crenulation folds on millimetre and centimetre scales respectively; related crenulation cleavage is present.

Lower Carboniferous carbonate rocks (**lCSc**) east of Mess Creek, which unconformably overlie Units **LDg** and **DSst**, are unaffected by this penetrative deformation. The rocks are deformed into open gentle folds on a scale of hundreds of metres. The folds are the only deformation recognized in the carbonates and may reflect movement in the underlying rocks.

The same fold geometry and relationships of Lower Devonian rocks are seen in Upper Carboniferous rocks underlying the plateau between Skeeter and Mess lakes. Foliated, thin-bedded tuffs and carbonates display recumbent isoclinal and tight parallel folds in cliff exposures on both sides of the plateau. Most folds have amplitudes on a scale of several metres. Fold axes plunge gently either northwest or southeast, and vergence appears to be to the northeast. Schistose and slaty beds also have millimetre and centimetre-scale crenulation folds. The massive basalt of Unit **uCSb** is weakly foliated but shows no evidence of folding.

The poor correlation between stratigraphic position and deformation suggests strata forming the ridge between Skeeter and Mess lakes have undergone a localized deformational event, possibly related to unrecognized thrust faulting.

Lower Permian volcanic rocks and carbonates east of Mess Creek are homoclinal; minor deviations in attitude are due to brittle faulting and disruption by intrusion of the Loon Lake stock. On the south slope of Tadekho Creek, the carbonate is involved in some large open folds. It is also drag folded adjacent to a minor north-trending fault about 4 kilometres southwest of Exile Hill. The most extensive deformation is adjacent to a well-exposed listric fault that places Lower Jurassic conglomerate against Lower Permian limestone. Approaching the fault from the east, bedding dips in the carbonate steepen from west to vertical, and become east dipping adjacent to the fault. The east-dipping beds are either overturned or the carbonate is tightly folded into an upright syncline in which the closure is not exposed.

Upper Triassic rocks east of Mess Creek have steep westerly dips. Most of the variation in attitudes in these rocks is probably caused by intrusion by the Loon Lake stock. Exposure is too poor to recognize large-scale folds; minor folds were observed in a small creek about 7 kilometres southwest of Nahta Cone. West of Mess Creek, Upper Triassic rocks dip steeply to the southwest and northeast, suggesting tight folding. The paucity of bedding attitudes in much of the section hinders recognition of folding. Tight noncylindrical folds do occur in well-bedded sandstone of Unit **uTSsn**. Well-bedded tuffs of Unit **uTSs** are drag folded into a shallow, open anticline against a normal fault, 5 kilometres north of the Schaft Creek deposit.

FAULTS

Curvilinear north-trending faults are the most significant structures in the Mess Lake area. They control topography and affect the distribution of nearly all rock units. Northeast-trending splays cut the ridge between Skeeter and Mess Lake valleys.

Movement along the faults took place during at least two separate episodes. The first episode of normal faulting uplifted rocks east of Mess Creek and Skeeter Lake relative to rocks to the west. The second episode had an opposite sense of displacement and uplifted rocks west of Mess Creek and Skeeter Lake relative to rocks to the east. The first episode brought Devonian rocks to the surface in Eocene time. Most of the movement was along faults presently located in Mess Creek and Skeeter Lake valleys. However, rocks as young as Early Jurassic were preserved in a listric fault block east of Loon Lake. The trace of the listric fault is well exposed and can be traced along the edge of the Arctic Lake plateau from just south of Nahta Cone to west of Arctic Lake in the More Creek map area. The fault juxtaposes a tilted block of east-dipping conglomerate of Unit **lJcg** and west-dipping volcanic, sedimentary and intrusive rocks of Units **uTSvp**, **uTSs** and **LTm** against west-dipping Lower Permian carbonate of Unit **lPSc**. A maroon, quartz-bearing fragmental unit is exposed along the entire length of the fault and appears to underlie Unit **lPSc**. We believe that the fragmental unit may be fault breccia (i.e., milled Unit **lJcg**).

The second episode of faulting uplifted rocks west of Mess Creek and Skeeter Lake along faults mainly to the east of the creek. The uplift was young enough to affect the distribution of Eocene and younger rocks to the east, and to cause the dramatic difference in topography across Mess Creek. East of Mess Creek, west-side-up faults repeat Lower Permian stratigraphy south of Tadekho Creek. Evidence of the sense of movement along these faults is found in a minor creek 4 kilometres southwest of Exile Hill, where drag folds in Unit **lPSc** clearly indicate west-side-up movement along a minor north-trending structure (Plate 1-9-2).

MINERAL PROPERTIES

The locations of mineral properties are shown in Figure 1-9-4. Their stratigraphic positions are shown in Figure 1-9-3 and details are summarized in Table 1-9-1.

Schaft Creek Porphyry Deposit

The Schaft Creek porphyry copper-molybdenum deposit is situated at the western edge of the map area, at an elevation of 1000 metres on the west-facing slope above Schaft Creek (Figures 1-9-1 and 1-9-4; Plate 1-9-3). Since its discovery in 1957, successive drill programs by Silver Standard Mines Ltd., American Smelting and Refining Company, Hecla Mining Company and Teck Corporation, the present owner, tested the property. The deposit is classified as a high-level calcalkaline volcanic porphyry (Linder, 1975; Fox *et al.*, 1976). It consists of a linear intrusive tourmaline breccia pipe, the Breccia zone, and the Main zone, a fracture-controlled zone of mineralization. Both are hosted in andesite flows and epiclastic rocks. Mineralization includes pyrite, chalcopyrite, bornite and molybdenite. Reserves are 910 million tonnes grading 0.3 per cent copper, 0.03 per cent molybdenum, 0.113 gram per tonne gold and 0.992 gram per tonne silver (Melville *et al.*, 1992).

The geology of the deposit is complicated and poorly exposed. Our visit consisted of one day looking at drill core and one day mapping drill roads and outcrops along the eastern edge of the deposit. Regional mapping traced the stratigraphy along ridges from the north and south into the deposit area. The following discussion presents our observations but the reader is directed to Linder (1975) and Fox *et al.* (1976) for discussions of the genesis, stratigraphy and mineralogy of the deposit.

Our observations of the Upper Triassic stratigraphy in the area of the deposit agree with observations of Fox *et al.* (1976). They note that 90 per cent of the deposit is in plagioclase-phyric and aphyric basalt flows and associated subvolcanic intrusions (**uTSvp**), massive tuffs, and bedded green and purple epiclastics (**uTSvt**). The epiclastic rocks are overlain by weakly mineralized mixed purple and green flow breccias and tuffs of units **uTSvt** and **uTSv**. Dike swarms of plagioclase porphyry, pyroxene plagioclase porphyritic diorite, felsite (aplite and quartz-eye feldspar porphyry) and hornblende porphyry, in order of abundance, cut the Upper Triassic volcanic rocks (Figure 1-9-3a). The felsic intrusives are bleached, altered and mineralized with disseminated and fracture-controlled sulphides.

No simple lithologic or stratigraphic difference was recognized between the purple volcanics and the mineralized green andesitic volcanics distinguished by earlier workers. The colour difference may reflect proximity to the intrusive and the centre of alteration and mineralization. Epidote clasts, originally probably mafic pumice fragments that have been completely replaced by epidote, and volcanic and

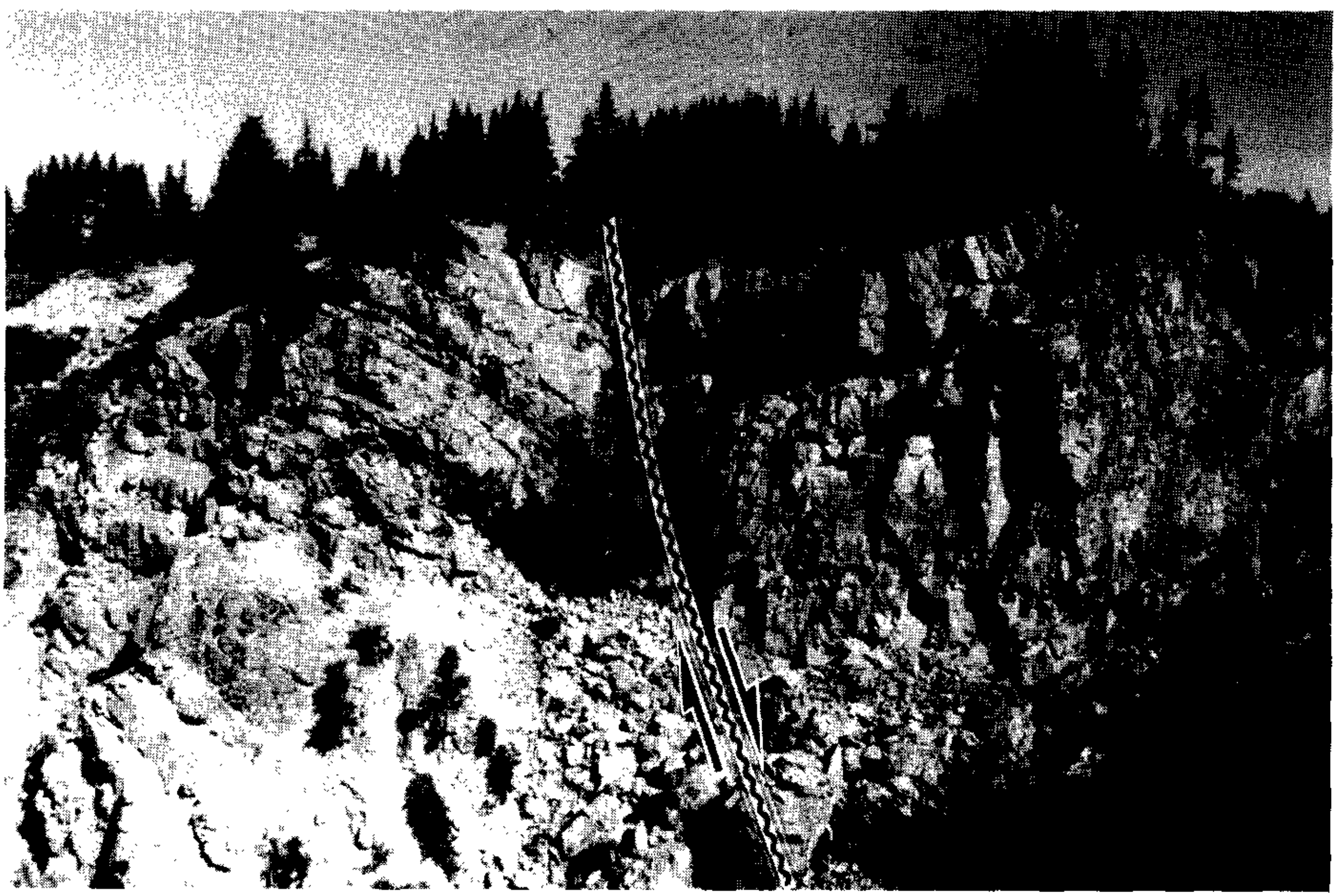

Plate 1-9-2. Drag folds in Lower Permian limestone of Unit lPSc indicating west-side-up movement along a north-trending fault east of Mess Creek. View is to the north.

TABLE 1-9-1
MINERAL OCCURRENCES FOR THE MESS CREEK MAP AREA (104G/07W)

TYPE/ PROB. AGE	MINFILE 104G	NAME	HOST	COMMODITY	DESCRIPTION	REFERENCE
GOLD-COPPER PORPHYRY						
Late Triassic - Middle Jurassic ?	015	SCHAFT CREEK	uTSvp, uTSvt LTmz	Cu, Mo, Au, Ag	Disseminated and fracture-controlled chalcopyrite, molybdenite, gold and silver mineralization is related to a high-level intrusive complex of felsic to intermediate dike swarms and a breccia pipe. Mineralization is discordant to volcanic stratigraphy. Unclassified reserves of 910 million tonnes grading 0.3% Cu,0.03% Mo, 0.113 g/t Au, and 0.992 g/t Ag.	Linder (1975), Fox et al. (1976), Melville et al. (1992)
Late Triassic ?	040, 41	RUN, MIX, RUN NORTH	uTSvp, LTmz	Cu, Au, Mo	Chalcopyrite, magnetite and pyrite disseminations and molybdenum on fracture selvages and in quartz veinlets cut crowded plagioclase porphyries and mafic volcanic rocks. Steep fracture and breccia zones control mineralization.	Gutrath (1971), Panteleyev (1973) Cloutier (1976)
Late Triassic ?	118	BB 57	uTSvp, LTpd	Cu	Trace amounts of disseminated chalcopyrite, magnetite, pyrite and bornite occur in fractured and sheared propylitic andesite, augite porphyritic diorite and monzodiorite.	House (1971)
Late Triassic ?	119	BB 38	uTSvt, uTSv	Cu	Trace amounts of disseminated chalcopyrite, magnetite and pyrite occur in fractured and sheared andesite.	House (1971)
GOLD-SILVER-QUARTZ VEINS						
Jurassic	057	COT & BULL	uCSc	Ag, Cu, Au	Disseminated blebs of tetrahedrite, chalcopyrite and pyrite occupy fractures and breccia zones in a bedding-parallel, east-trending fault cutting limestone. Mineralization either predates or is syngenetic with a north-trending basalt dike dike swarm.	Betmanis (1981), Howgill and Walton (1986)

intrusive fragments that are variably replaced by epidote, occur within purple volcanic flows and tuffs of Units **uTSvt** and **uTSv**. The presence of epidote defines a propylitic alteration zone marginal to mineralization. South of the deposit, this stratigraphy is unconformably overlain by quartz-eye felsic tuffs and quartz-bearing Lower Jurassic conglomerates that contain epidote clasts and clasts of epidotized volcanic rocks.

In the areas south and east of the deposit, the overall strike of bedding is north-northwesterly with easterly and westerly dips that average 70°. Locally strikes are northeasterly, also with steep dips, suggesting tight folds. Other workers describe gentle east dips for bedding in the western part of the deposit, suggesting a simple synclinal structure. Northwest, north and northeast-trending faults truncate the deposit and produce a mosaic of fault blocks with varying internal structure and stratigraphy.

The deposit is hosted by Upper Triassic volcanic rocks of the *Stuhini Group* adjacent to the eastern contact of the coeval Hickman pluton, where it is cut by the Middle Jurassic Yehiniko pluton. These intrusive events are well constrained by K-Ar dates (Holbek, 1988). The timing of mineralization is not well constrained. It could be related to either plutonic event or perhaps in between and Early Jurassic. A whole-rock K-Ar date for hydrothermal biotite is 185±5 Ma (Panteleyev and Dudas, 1973). This may reflect: the age of mineralization, argon lost due to Middle Jurassic resetting, or excess argon. In the hopes of establishing an age for the deposit, we collected a zircon sample from quartz monzonite porphyry intrusive known to be spatially and temporally associated with the mineralizing system.

Other Porphyry Prospects – Run

The Run property is located approximately [illegible]0 kilometres southeast of the Schaft Creek deposit, on the east side of Mess Creek (Figure 1-9-4). No active exploration was carried out on the Run claims during the summer of 1992.

The claims are underlain by a salmon-pink weathering plagioclase hornblende porphyritic monzonitic intrusion (**LTmz**). Rafts of hornfelsed lapilli and crystal tuff are exposed where creeks are incised into the main intrusive body. Farther upslope, dikes of pink monzonite intrude a thick package of plagioclase-phyric basalt flows, tuffs and subvolcanic gabbro dikes and plugs of Late Triassic age (Figure 1-9-3b).

Fractures, faults and intrusive breccias control alteration and stockwork mineralization. The monzonite contains magnetite to several per cent, partly altered to hematite.

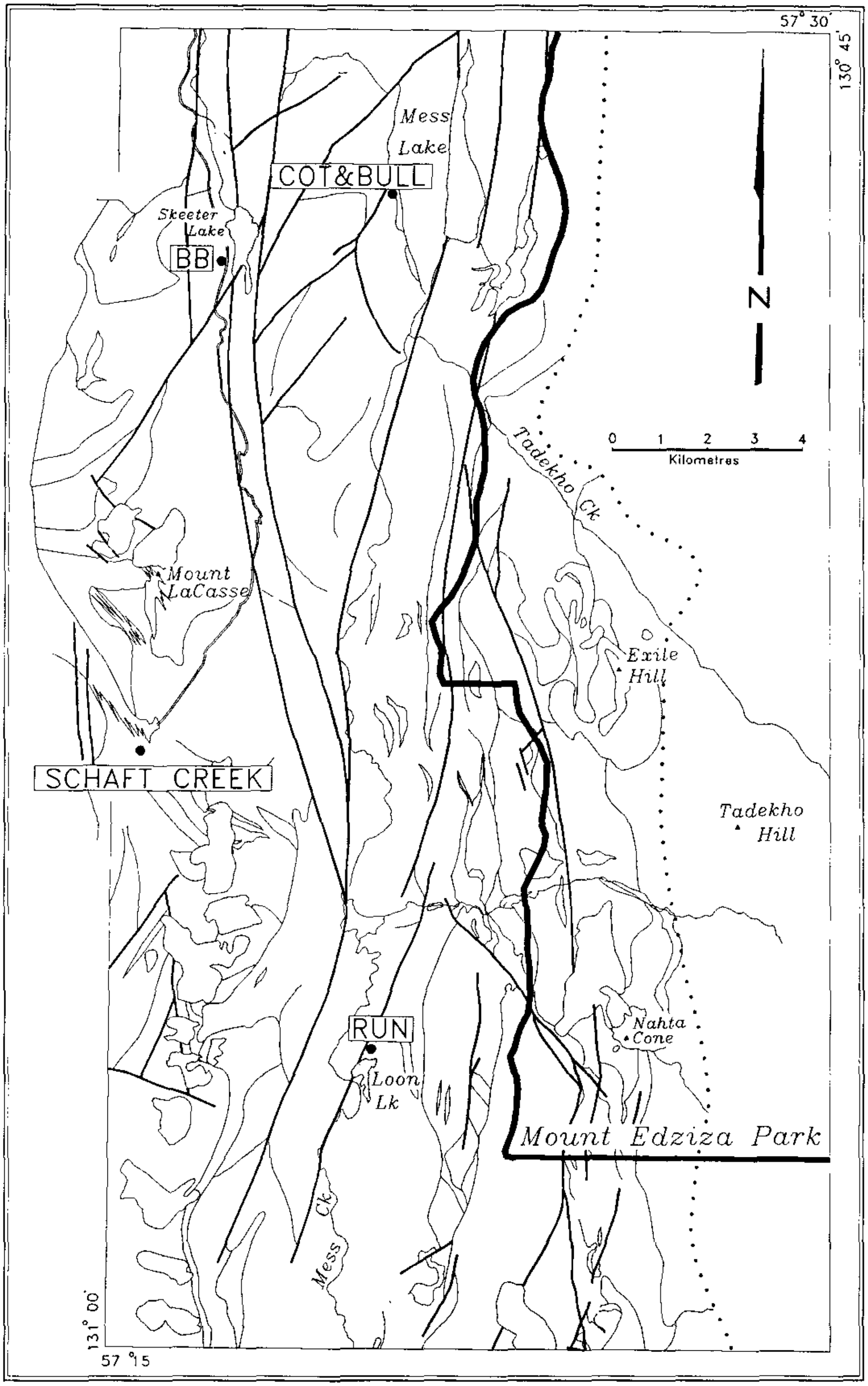

Figure 1-9-4. Mineral occurrence map showing locations of occurrences discussed in text and shown in stratigraphic position in Figure 1-9-3.

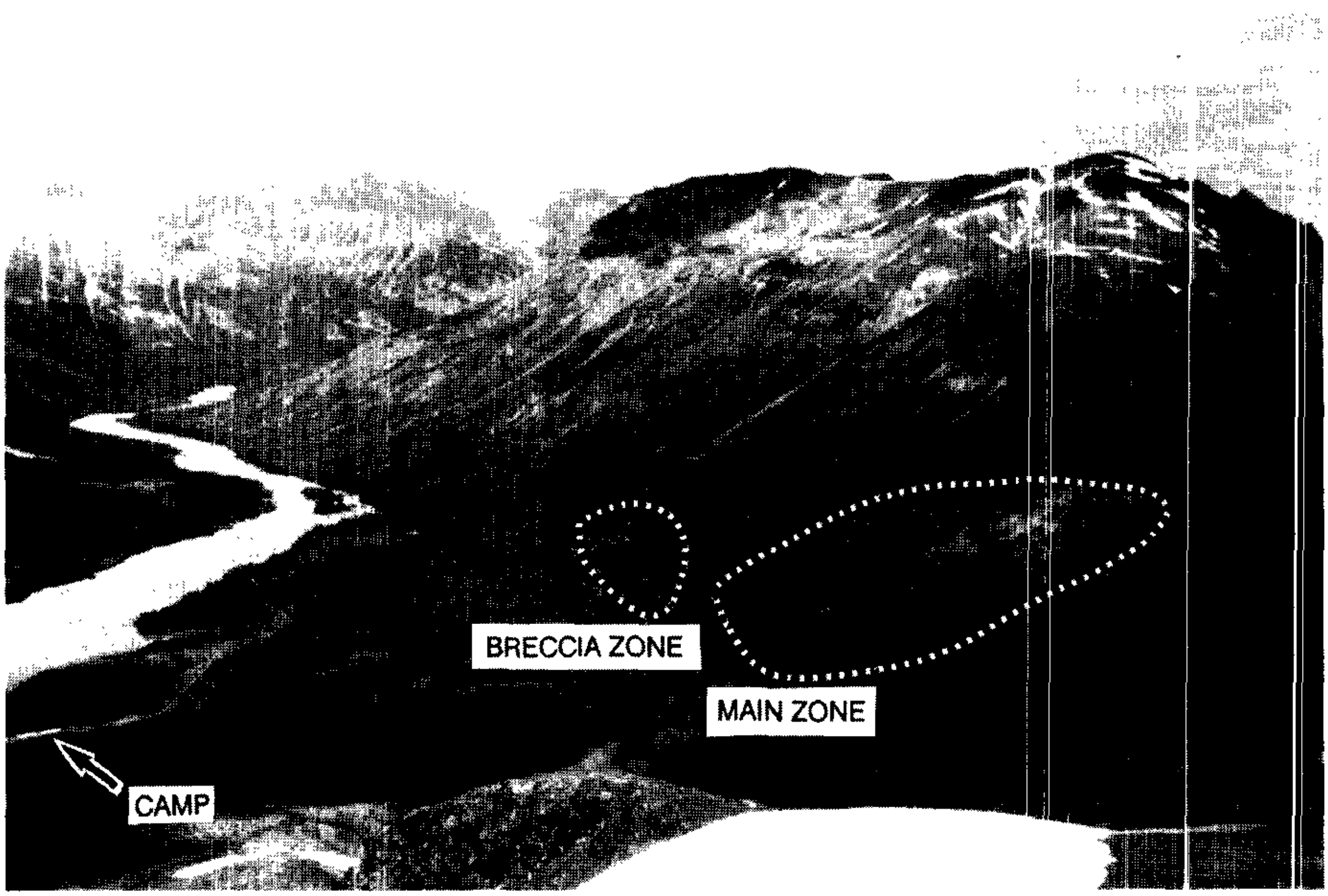

Plate 1-9-3. The Schaft Creek porphyry deposit lies east of Schaft Creek, on the lower slopes of Mount LaCasse. View is to the north.

Locally pyrite ranges to 10 per cent. Chalcopyrite, molybdenite and local chalcocite occur as disseminations and fracture fillings in the monzonite and in quartz veinlets in the volcanic rocks.

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