GEOLOGY OF THE AIKEN LAKE AND OSILINKA RIVER AREAS, NORTHERN QUESNEL TROUGH (94C/2, 3, 5, 6 & 12)

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(Canada - British Columbia Mineral Development Agreement 1991-1995)

KEYWORDS: Regional geology, Quesnel trough, Quesnel Terrane, Cassiar Terrane, Harper Ranch Terrane, Slide Mountain Terrane, Hogem intrusive complex, Takla Group, Lay Range assemblage, ultramafic intrusions, strike-slip faults, metamorphism, porphyry, copper-gold, carbonate-hosted, lead-zinc.

INTRODUCTION

This report summarizes the second year of the Aiken Lake project which is a 1:50 000-scale mapping program funded by the Canada – British Columbia Mineral Development Agreement (1991-1995). The project consists of three years of field mapping, covering an area extending from Uslika Lake northward to Johanson Lake (Figure 1-8-1). Mapping has focused on the northern limit of Mesozoic volcanics within the Quesnel trough (Quesnel Terrane), upper Paleozoic oceanic volcanics and sediments of the Harper Ranch Terrane and Paleozoic carbonates of the Cassiar Terrane. The project area has known porphyry copper-gold and carbonate-hosted lead-zinc occurrences and the potential for economic mineral concentrations. The primary goal of this project is to provide detailed geological base maps in support of the search of new mineral discoveries. Secondary goals include an update of the mineral inventory database and the placement of known mineral occurrences within a geological framework. Stream-sediment samples from creeks and lithogeochemical samples of prospective lithologies were collected for the purpose of outlining areas of higher than average mineral potential and to assist in defining metallotects.

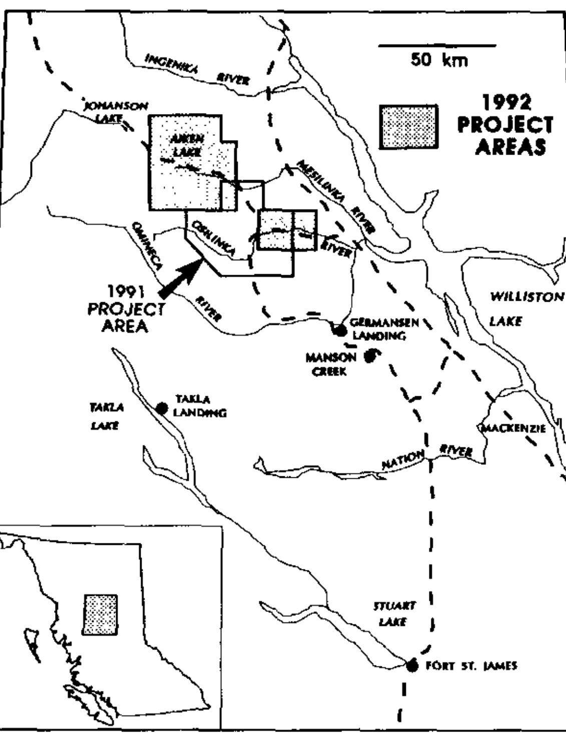

Figure 1-8-1. Location of the map area.

Mapping during the 1992 field season concentrated on the Aiken Lake and Osilinka River areas (Figure 1-8-1). The Aiken Lake map area includes most of NTS map sheet 94C/5 together with parts of 94C/6 and 94C/12. The Osilinka River map area includes parts of 94C/2 and 94C/3 These areas are located 200 to 250 kilometres north-northwest of Fort St. James (Figure 1-8-1). Road access is by the gravel, all-season Omineca mining access road from Fort St. James, or a similar forestry access road which originates at the southern end of Williston Lake. These roads follow the Mesilinka, Osilinka and Tenakihi drainages and connect to numerous secondary logging roads in the area. Almost all of the Osilinka map area is accessible by gravel roads. In contrast only 30 per cent of the Aiken Lake map area has road access. The Omineca mining access road follows the Mesilinka River and Lay Creek valleys in the Aiken Lake area. A major logging road almost reaches the mouth of Abraham Creek along the south side of the Mesilinka River. An old 4x4 track leads through the broad valley north of Black Pine Lake to the Ingenika mine or the Ingenika River.

This year's work in the Aiken Lake map area is contiguous with mapping completed during the 1991 field season (Ferri *et al.*, 1992a, b). The first geological map of the Aiken Lake area was produced by Lay (1940) who described the geology along the major drainages in the area. Roots (1954) produced a 4-mile geological map for the west half of the Mesilinka sheet in the first comprehensive geological study of the area. Detailed mapping within the map area has been produced by Zhang and Hynes (1991, 1992) who are studying the Takla Group on both sides of the Finlay fault. Bellefontaine (1989, 1990) carried out an in-depth structural study along the western margin of the Cassiar Terrane on the east side of the Swannell River. The east half of the Mesilinka sheet was mapped by Gabrielse (1975) and mapping to the south was published at 6-mile scale by Armstrong (1949). Detailed geological studies of Paleozoic rocks within the map area were completed by Monger (1973) and Monger and Paterson (1974) and were summarized, in part, by Monger (1977). Parrish (1976, 1979) carried out a structural and geochronological study of metamorphosed Ingenika Group rocks between Blackpine

Lake and Chase Mountain. Irvine (1974, 1976) described Alaskan-type ultramafic bodies around Aiken Lake. Unpublished detailed geological maps of the Lay Range and surrounding areas compiled by J.W.H Monger of the Geological Survey of Canada were incorporated into this map. Garnett (1978) carried out a study of the southern Hogem intrusive complex and Meade (1975) mapped Takla Group rocks in the Germansen Lake area.

Detailed mapping by the British Columbia Geological Survey in this area includes the Manson Creek project (Ferri and Melville, 1988, 1989, 1990a, b, in preparation; Ferri *et al.*, 1988, 1989). The Manson Creek and Aiken Lake projects are contiguous with mapping by the Nation Lakes project (Nelson *et al.*, 1991, 1992, 1993). Nixon (1990) and Nixon *et al.* (1990a, b) produced detailed maps and descriptions of the Polaris Ultramafic Complex.

Mapping along the Osilinka River covered a small area of Paleozoic rocks north of End Lake. This provided complete coverage of these important Paleozoic rocks; it has also led to some reinterpretation of the complex geology in adjacent map areas covered during the Manson Creek and Aiken Lake projects.

Many of the unit names used in this paper are informal and have been defined by various authors in the region (*see* Ferri *et al.*, 1992a; Nelson *et al.*, 1992; Ross and Monger 1978). This is reflected by the use of lower case lettering at the group and formation levels.

REGIONAL GEOLOGY

The project areas straddle the boundary between the Intermontane and Omineca geomorphological belts of the Canadian Cordillera. They are underlain by accreted volcanic rocks of the Intermontane Superterrane and displaced rocks of continental margin affinity (Wheeler and McFeely, 1991; Figure 1-8-2).

Parts of at least four tectonostratigraphic terranes are exposed in the map areas. The easternmost rocks are displaced continental rocks of the Cassiar Terrane. To the extreme west lies the Mesozoic island-arc terrane of Quesnellia. These terranes are separated by two upper Paleozoic terranes in the Osilinka River map area; the volcanic(arc?)-sedimentary Harper Ranch Terrane, and the oceanic Slide Mountain Terrane. The Slide Mountain Terrane is absent in the Aiken Lake map area.

Strata of the Cassiar Terrane include the Upper Proterozoic Ingenika Group through to the Mississippian to Permian Cooper Ridge group. These rocks are predomi-

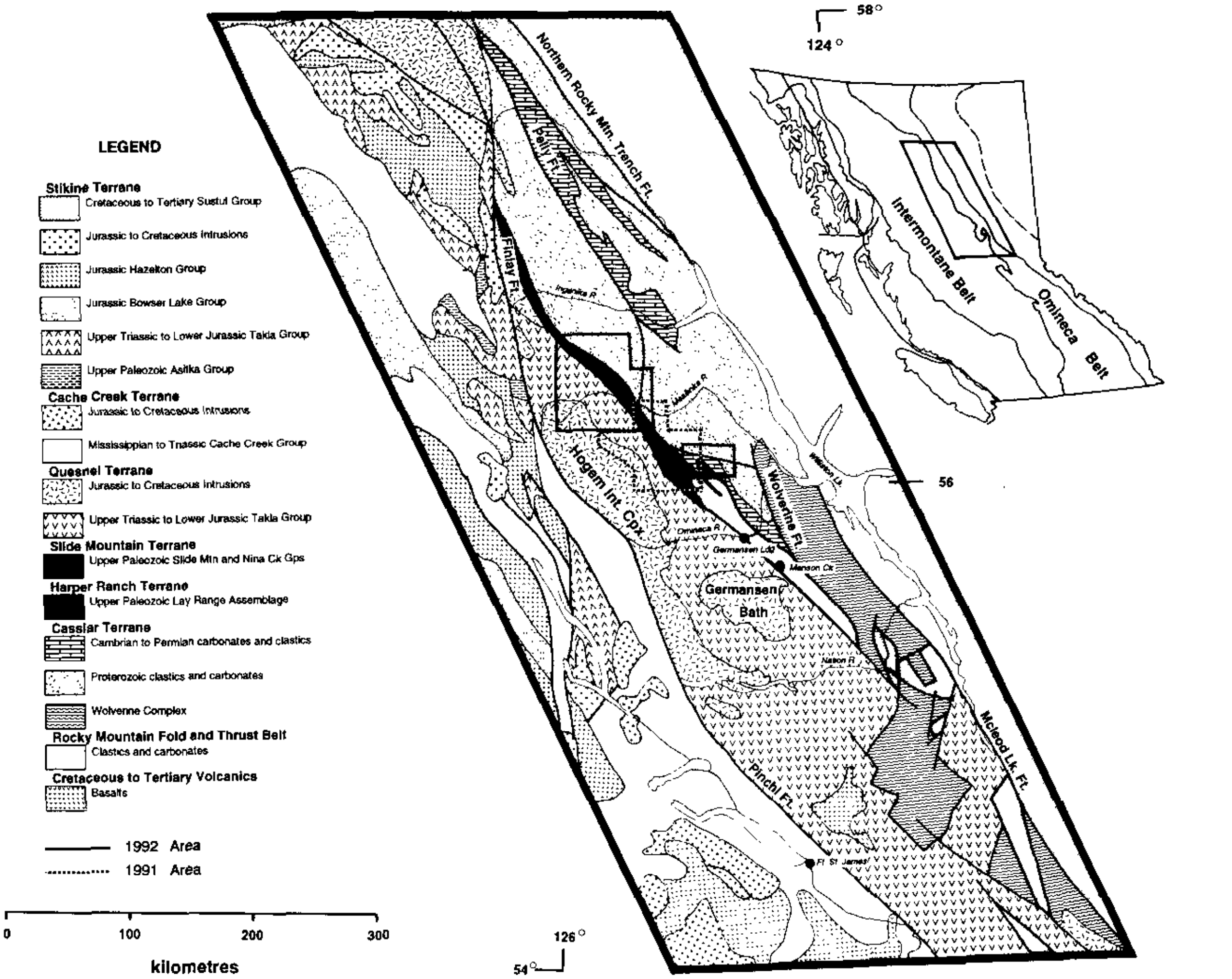

Figure 1-8-2. Regional geological setting of the Uslika map area. *See* text for details.

nantly clastic with carbonates becoming more common higher in the stratigraphy. The structurally and stratigraphically lower parts of this sequence are polydeformed and metamorphosed to sillimanite grade and outcrop as core complexes (Wolverine, Butler).

In the Osilinka River area the Slide Mountain Terrane lies structurally above the Cassiar Terrane. It is represented by the Pennsylvanian to Permian Nina Creek group (Ferri and Melville, in preparation). This package is composed of oceanic volcanic and sedimentary rocks (pillow basalts and cherty sediments) which have been thrust onto North American rocks.

The Quesnel Terrane is represented by the Upper Triassic to Lower Jurassic Takla Group (Roots, 1954). This is a volcanic and sedimentary arc sequence which is intruded along its western margin by the Triassic to Cretaceous Hogem intrusive complex (Garnett, 1978) and related intrusions. The eastern part of Quesnellia is further subdivided, in this area, into the Harper Ranch Subterrane (Wheeler and McFeely, 1991). This subterrane is represented by the enigmatic upper Paleozoic Lay Range assemblage, a package of volcanic and sedimentary lithologies with predominantly arc affinities although some of the sedimentary units suggest continental origins. Takla Group and Lay Range assemblage rocks are intruded by several ultramafic bodies, the most notable being the Polaris Ultramafic Complex.

OSILINKA RIVER AREA

Lithologic Units

NORTH AMERICAN CASSIAR TERRANE

An exhaustive description of Cassiar stratigraphy in this area will not be attempted here. Lithologic units are identical to those described in previous articles and the reader is referred to these for detailed descriptions (Ferri and Melville, 1989; Ferri *et al.*, 1992a; Figure 1-8-3). The discussion here will focus on new data or insights into each unit and any reinterpretation of previous work.

Ingenika Group to Big Creek group stratigraphy is recognized in the area straddling the Osilinka River. These rocks are exposed within a broad, northwest-trending syncline and can be traced across the Osilinka River into the Beveley Mountain area where they are cut by a series of steep normal faults and placed against higher grade rocks of the Swannell Formation.

Razorback rocks are seen in rubble along the main logging road on the north side of the Osilinka River and in several rubbly outcrops along the ridge to the north. The unit was also recognized along several logging-road cuts on the south side of the Osilinka River. These shales were originally thought to belong to the Echo Lake group but the recovery of Early Ordovician graptolites suggests that they are part of the Razorback group. Their occurrence within rocks of the Echo Lake group suggests a thrust fault repeating Echo Lake strata. The Razorback group is characterized by grey and dark grey slate, argillite and argillaceous limestone. Its thickness is approximately 50 to 75 metres and its exposure is quite poor. The trace of this unit is, in part, based on the recessive notch it produces between carbonates of the Atan and Echo Lake groups.

Middle Ordovician shales on the east side of Wasi Creek, that were originally mapped as Echo Lake group, are now thought to be the Razorback group. This interpretation is based primarily on regional trends and on the reassessment of carbonates below these shales which are now believed to be the Lower Cambrian Mount Kison formation.

Two subdivisions of the Echo Lake group are recognized in the area: the basal limestone and dolomite up to 600 metres thick, and the succeeding sandy dolomite which can approach several hundred metres in thickness. The lower section is characterized by thick successions of grey to white fenestral dolomite (Plate 1-8-1). The Echo Lake group is commonly more dolomitic than carbonates of the Mount Kison formation, and contains areas of silica replacement. Thick sequences of massive limestone within this succession are difficult to distinguish from the Mount Kison formation.

The sandy dolomite unit is well exposed along the main logging road on the north side of the Osilinka River. Well-rounded, spherical quartz grains constitute up to 50 per cent of the rock and are found within thickly cross-stratified

Plate 1-8-1. Sample of typical Echo Lake group fenestral dolomite from the Osilinka River area. This lithology forms thick sequences in the lower part of the Echo Lake group and helps distinguish it from carbonates of the Atan Group.

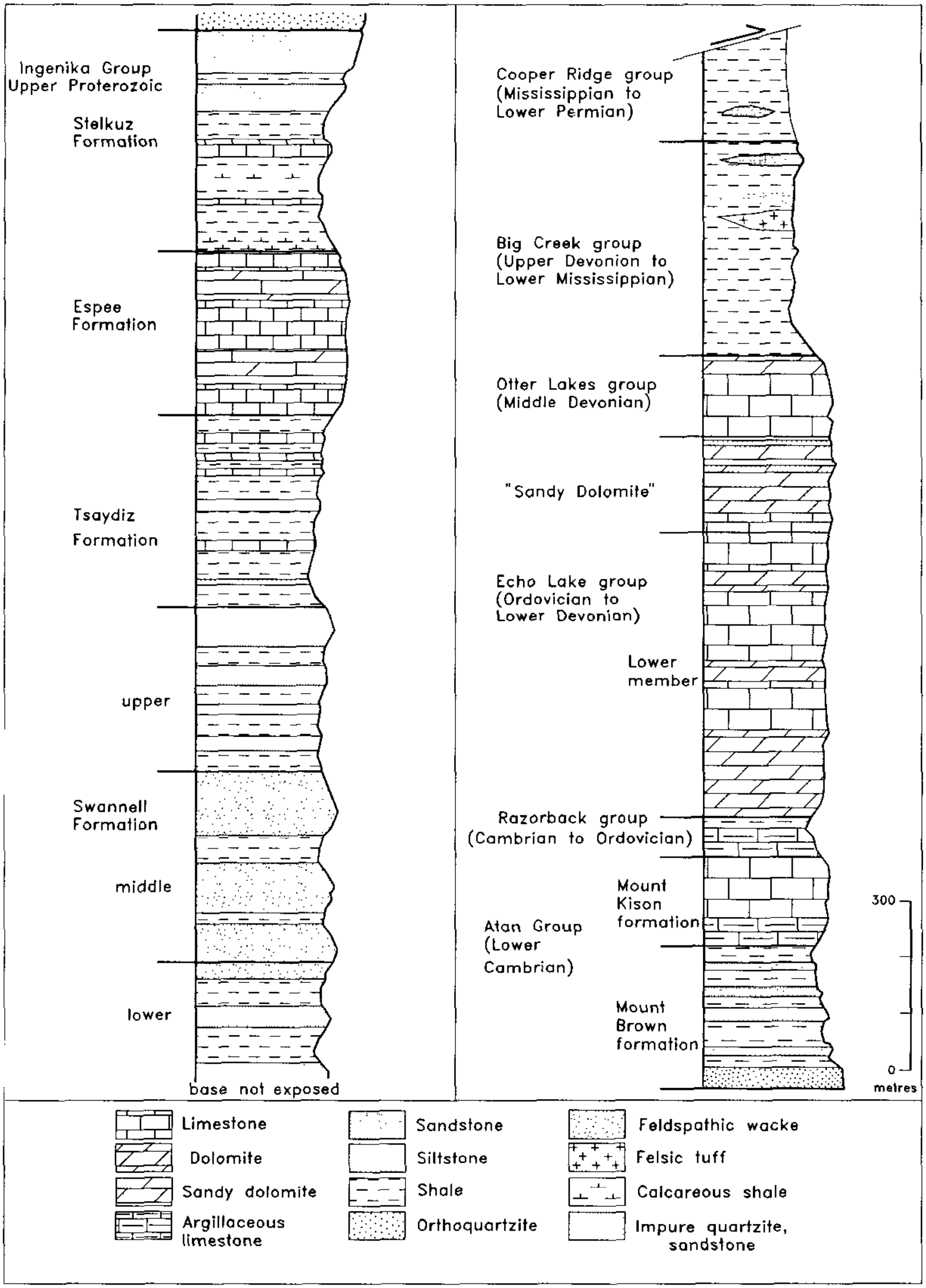

Figure 1-8-3. Generalized stratigraphic columns of Cassiar Terrane in the Osilinka River area (from Ferri and Melville, in preparation).

horizons. Twin-holed columns of several crinoid species were found at this locality and suggest a late Early Devonian (Emsian) age for the uppermost part of the Echo Lake group (B.S. Norford, personal communication, 1992). Middle Ordovician graptolitic shales, originally thought to be part of the Echo Lake group, are now known to belong to the Razorback group. This suggests that the lower age limit of the Echo Lake group is Middle Ordovician.

One of the distinguishing characteristics of the Echo Lake group in this area is the presence of carbonate breccia or conglomerate. Two types are seen: one which appears to be primary (*i.e.*, debris flows) and the other secondary. Primary breccia is characterized by locally derived carbonate clasts set in a limy mud matrix, or sandy matrix if found within the upper sandy dolomite unit. Clasts are up to tens of centimetres in size. The thickness of these deposits is difficult to deduce but is thought to be in the tens of metres.

Secondary breccia is characterized by metre-scale angular blocks separated by sparry dolomite or calcite which may display several generations of infilling. Some areas appear autoclastic (*i.e.*, fragmented in place). The origin of this breccia is not known. It may be either a solution collapse breccia or one related to faulting, though many features do not support a tectonic origin. A third possibility is that these occurrences are of debris-flow origin and the original limy mud has been selectively replaced by sparry carbonate.

Conodonts were recovered from the Otter Lakes group east and west of Wasi Creek. Both these localities yield faunas with a late Early to early Middle Devonian age range (Emsian to Eifelian; M.J. Orchard, personal communication, 1992) which is consistent with past interpretations of this unit.

The extent of the Big Creek group has increased in our present interpretation of the geology. Felsic tuff originally assigned to the Lay Range assemblage (dacitic tuff unit, MPlr4, in Ferri *et al.*, 1992a, b) is now known to be within the upper part of the Big Creek group. Mapping of Big Creek group stratigraphy in the Aiken Lake area has delineated a similar package of felsic tuff in support of this. The inferred fault separating Big Creek from Unit MPlr4 is not required and this contact is now reinterpreted as stratigraphic. This felsic tuff is known as the Gilliland tuff in the Germansen Landing area (Ferri and Melville, in preparation) and is lower Mississippian. Similar tuff is found east of Wasi Creek, but is much thinner. This tuff has regional extent as it has now been recognized from the Aiken Lake to Germansen Landing areas. The large expanse occupied by this unit west of Wasi Creek is not only a function of its substantial thickness but also due to broad, low-amplitude folding recognized immediately to the southeast.

The Big Creek group (and Gilliland tuff unit) is now thought to underlie the Nina Creek group east of Wasi Lake and Wasi Creek (Figure 1-8-4). Felsic tuff formerly mapped as Unit PPnhb of the Mount Howell formation (lower Nina Creek group, Ferri *et al.*, 1992b) is now grouped with the Gilliland tuff; shales and argillites below this are also considered part of the Big Creek group. Furthermore, shales, argillites, cherty argillites and tuffaceous units exposed at the mouth of the creek which flows into the northeast end of Wasi Lake are now also believed to be part of the Big Creek group. These changes better reconcile the geology on either side of the Wasi Lake - Wasi Creek drainage, with the result that the offset on the fault along the lower part of Wasi Creek is not as large as previously interpreted.

Dark grey to grey, wavy to planar-bedded argillites and shales, and minor massive beds of brown to grey limestone are found above typical Big Creek lithologies on the east side of the syncline south of the Osilinka River. These rocks have been informally termed the Cooper Ridge group by Ferri and Melville (in preparation). This package was originally placed in the Slide Mountain Terrane as Unit PPsml by Ferri and Melville (1990b). However, conodonts subsequently recovered from the limestones in the upper part of this unit returned an Early Permian age; also, Ross and Monger (1978) recovered fusilinids of probable Early Permian age from limestones of this unit. This suggests continuous North American deposition in this area until at least the Early Permian and that the rocks of the Cooper Ridge group belong to the Cassiar Terrane. The presence of the Cooper Ridge group north and west of Whistler Mountain is less certain. Argillaceous rocks above the Otter Lakes group and below the Nina Creek group have been placed with the Big Creek group. The possible absence of Cooper Ridge rocks in this area may be due to lack of deposition or removal by the thrust fault at the base of the Nina Creek group.

Echo Lake group carbonates on the Osprey mineral claims are intruded by a small, grey, aphanitic and intermediate to felsic body. The intrusion is less than 10 metres in diameter, and associated with sulphide mineralization. Its undeformed nature suggests it is related to possibly Tertiary felsic intrusions into the Swannell Formation near Beveley Mountain.

SLIDE MOUNTAIN TERRANE

The lower part of the Nina Creek group was mapped south of the Osilinka River. These wavy bedded argillites, siliceous argillites and bedded cherts are part of the Mount Howell formation. Minor lithologies include chert-quartz wackes (with 10% to 20% coarse clastic material) and brown argillaceous limestone. The uppermost exposed parts are intruded by gabbro sills.

STRUCTURE

Late northwest and northeast-trending normal faults are the most dominant structural elements in the Osilinka map area. These faults cut the broad syncline below Mount Howell and truncate it to the northwest against polydeformed rocks of the Swannell Formation. The fault zones are quite wide, as exemplified north of the Childhood Dream mineral occurrence where several hundred metres of strongly fractured and crumbly carbonate of the Echo Lake group are placed against the Swannell Formation. The juxtaposition of garnet-grade Swannell Formation rocks against those of the Echo Lake group suggests that displacement on segments of these faults is in the order of kilometres.

Mapping along the Osilinka River has allowed the harmonization of the geology between the Beveley Mountain area and that south of the river. In the Beveley Mountain area the northwest-trending, southwest-side-down normal fault that separates a wedge of carbonates from the Swannell Formation must connect with the similar, large northwest-trending fault (with similar sense of displacement) south of the Osilinka River (Ferri and Melville, 1990a, b). Furthermore, a similar fault to the southwest begins northeast of Wasi Lake, separating the Nina Creek group from Cassiar Terrane, and continues northwestward along Tenakihi Creek.

A northwest-trending, southwest-side-down normal fault inferred along the lower part of the Osilinka River (Ferri and Melville, 1990a, b) must exist and veer northward to separate the Paleozoic succession from Swannell rocks. It ultimately trends southeastward into the Wolverine fault zone, a steep brittle-ductile shear zone along the west side of the Wolverine Metamorphic Complex.

The major northeast and east-trending faults north of the Osilinka River are not parallel to any other major faults in the area.

A thrust fault (End Lake thrust) is now known to repeat Razorback and Echo Lake stratigraphy south of the Osilinka River and must continue northward. Evidence for this fault is provided by the strongly brecciated Razorback and Echo Lake lithologies several kilometres south of the Osilinka River. This fault would help to explain the thickness of the Echo Lake group in this area. Displacement on the fault appears to decrease southward and the fault must terminate just south of the map area in Figure 1-8-4.

AIKEN LAKE AREA

Lithologic Units

NORTH AMERICAN CASSIAR TERRANE

Cassiar Terrane rocks described by Ferri *et al.*, (1992a) in the Uslika Lake area are also recognized in the Aiken Lake map area (Figure 1-8-5). Lithologies are similar except for minor differences which may reflect regional facies variations. Units of the Proterozoic Swannell Formation to the Devono-Mississippian Big Creek group are exposed within a southwest-dipping panel cut by late normal faults. The Middle Devonian Otter Lakes group is not recognized. It is not certain whether this is due to lack of deposition or poor exposure.

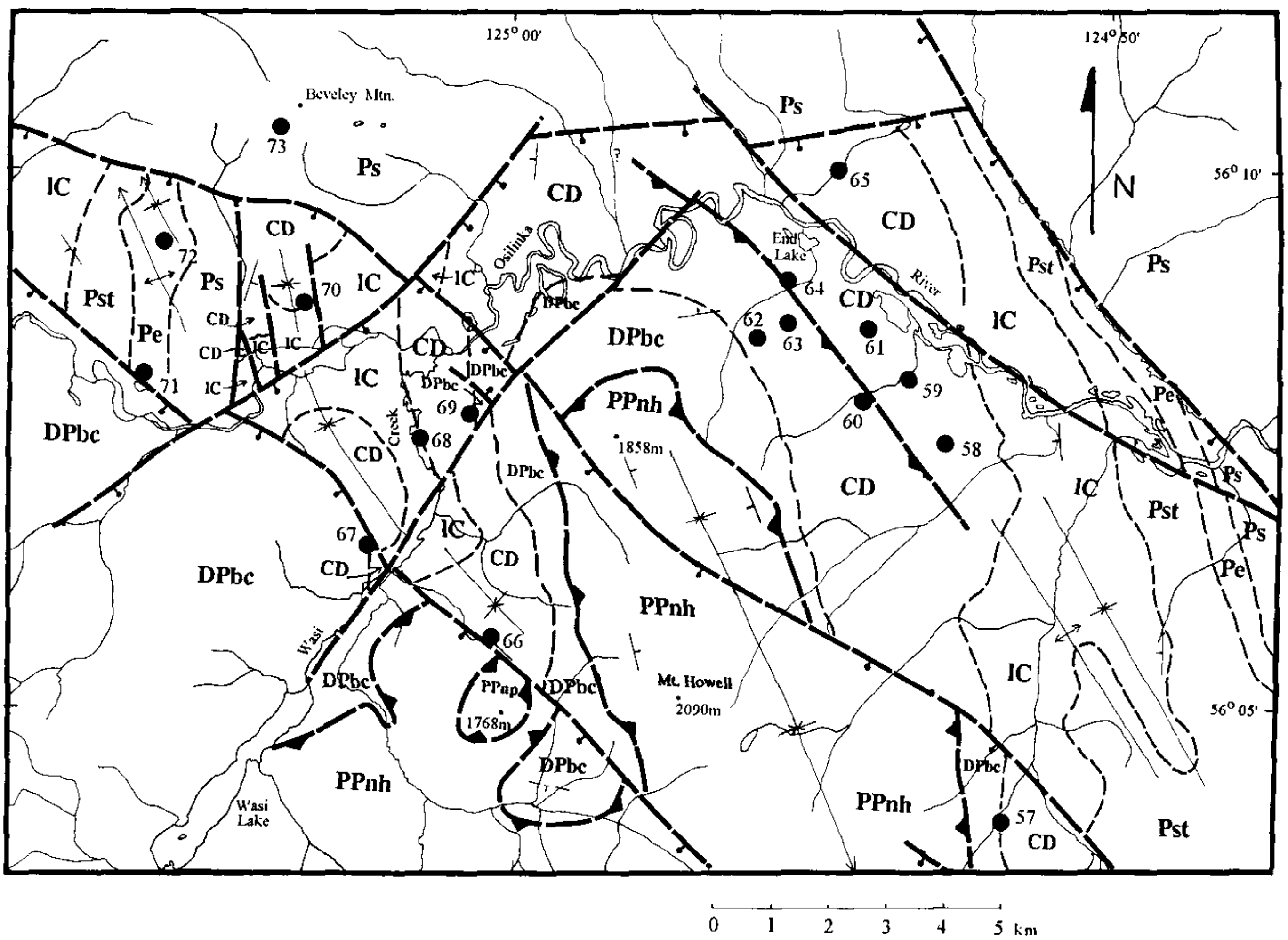

Figure 1-8-4. Geology of the Osilinka River map area.

LAYERED ROCKS

Upper Cretaceous to Tertiary

KTm — ***maroon conglomerate unit:*** *conglomerate sandstone, , siltstone*

Lower Cretaceous(?)

lKc — *conglomerate, sandstone, siltstone, argillite, minor coal*

Triassic to Jurassic

Upper Triassic to Lower Jurassic

Takla Gp

uTrlJt — ***maroon tuff unit:*** *maroon to green, tuffs agglomerates, , plagioclase and augite-phyric*

Upper Triassic

uTrp2 — ***Plughat Mountain fm:*** *augite-plagioclase phyric agglomerates, basalts, tuffs*

uTrp1 — ***Plughat Mountain fm:*** *tuffs, tuffaceous, siltstone, argillite, agglomerate minor limestone*

Paleozoic or Mesozoic

PM — ***problematic unit:*** *tuffs, argillites, siltstone, limestone, agglomerate*

Pennsylvanian to Permian

Nina Creek Gp

PPnp — ***Pillow Ridge fm:*** *massive to pillowed basalt, lesser chert, argillite, gabbro*

PPnh — ***Mount Howell fm:*** *argillite, chert, gabbro, minor basalt, wacke, felsic tuff*

Mississippian to Permian

Lay Range Assemblage

Middle Pennsylvanian to Permian

PPlru — ***upper mafic tuff division:*** *tuffs to siltstones, agglomerate, basalt, argillite, gabbro, limestone*

Mississippian to Middle Pennsylvanian

MPlrl — ***lower sedimentary division:*** *mixed argillite, conglomerate, limestone, sandstone, tuff*

Devonian to Permian

Upper Devonian to Lower Permian

Big Creek gp, Cooper Ridge gp

DPbc — *shale, argillite, wacke, sandstone, felsic tuff, minor limestone*

Cambrian to Devonian

Cambrian to Middle Devonian

Razorback gp,

Echo Lake gp, Otter Lakes gp

CD — *limestone, dolomite, lesser cherty carbonate, sandy dolomite, argillite*

Lower Cambrian

Atan Gp

lC — *limestone, shale, siltstone, quartzite*

Upper Proterozoic

Ingenika Gp

Pi — ***Undivided:*** *impure quartzite, schist, phyllite, limestone, arkosic wacke and sandstone*

Pst — ***Stelkuz Fm:*** *phyllite, slate, sandstone, limestone*

Pe — ***Espee Fm:*** *limestone, dolomitic limestone,*

Pts — ***Tsaydiz & Swannell Fms:*** *phyllites, limestone, arkosic sandstone, phyllite, schist,*

INTRUSIVE ROCKS

Late Triassic to Cretaceous

Hogem intrusive complex

TrKh — *monzonite, quartz monzonite, syenite, granodiorite, granite, diorite*

Triassic or Jurassic

mafic-ultramafic body

TrJmg — *gabbro*

TrJmp — *Peridotite, pyroxenite, hornblendite, gabbro*

Lower Jurassic

Polaris Ultramafic Complex

lJp — *Dunite, wehrlite, pyroxenite, gabbro*

Geologic contact

Fault (undefined, normal, thrust)

Bedding orientation (tops known, unknown)

Bedding orientation, overturned

Fold (anticline, syncline, overturned anticline)

Limit of mapping

Stratigraphic section location .... A

Structural cross-section location .... A - A'

Mineral occurrence 21

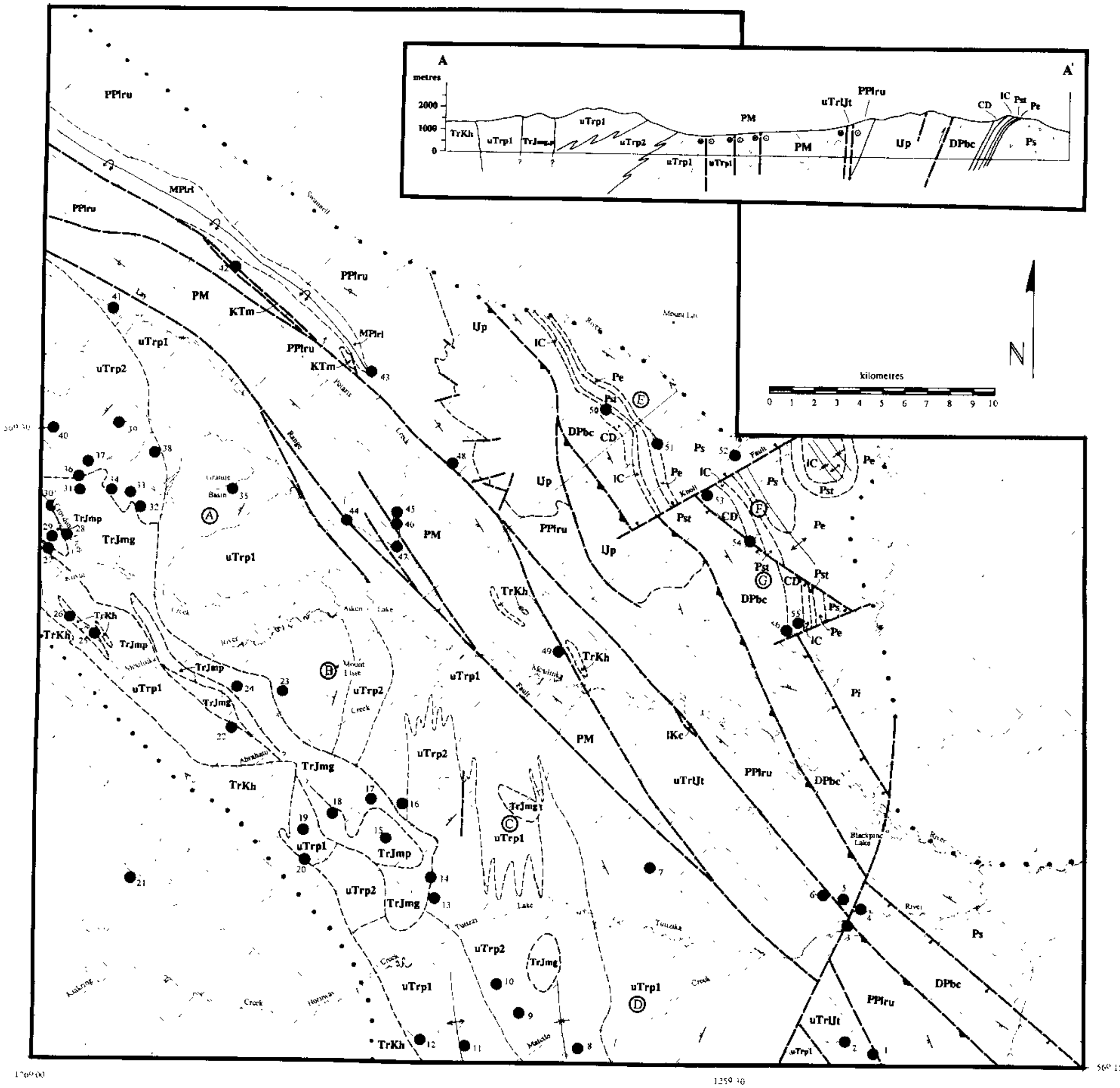

Figure 1-8-5. Geology of the Aiken Lake map area. Insert at top left is a cross-section through the middle of the map area.

Cassiar rocks are found in the northeastern part of the Aiken Lake map area and are dominated by the Proterozoic Ingenika Group. This is overlain by Paleozoic strata which show abrupt changes in thickness and lithology along strike. Paleozoic rocks in the map area include both a thick platformal sequence, typical of stratigraphy in the Osilinka River area, and a thin argillaceous basinal(?) succession which has not yet been mapped in this region.

Ingenika Group (Upper Proterozoic)

The four formations of the Ingenika Group (defined by Mansy and Gabrielse, 1978) crop out in the map area. These are, from oldest to youngest, the Swannell, Tsaydiz, Espee and Stelkuz formations. Swannell rocks roughly correspond to the Tenakihi Group of Roots (1954) with the remaining formations being part of his lower Ingenika Group. The thickness of this package is estimated to be a minimum of 2800 metres.

Swannell Formation: Approximately 700 metres of semicontinuous outcrop of the Swannell Formation is exposed along a ridge south of the Swannell River. A further, stratigraphically lower 1400-metre section is inferred from exposures along the Swannell River, indicating a total thickness approaching 2100 metres. This minimum thickness is in accordance with sections described elsewhere in the Cassiar Terrane (Roots, 1954; Mansy and Gabrielse, 1978; Ferri and Melville, 1990a).

An upper and lower sequence are recognized along the ridge section. The upper part is roughly 500 metres thick and composed of interlayered grey to tan, very fine to coarse-grained sandstone to feldspathic sandstone and grey to silvery grey or green phyllite to quartzitic phyllite. Phyllitic lithologies commonly make up less than 30 per cent of the outcrop. Sandstone beds are up to 1 metre thick and contain up to 40 per cent phyllitic material. This unit becomes schistose down-section as the metamorphic grade increases.

The lower sequence is composed of thick to massively bedded arkosic psammites (feldspathic grits) interlayered with thin to thickly bedded, green to brown phyllite or schist which may contain porphyroblasts of garnet, biotite and chloritoid. Pelitic rocks comprise less than 20 per cent of the outcrops. Only 200 stratigraphic metres of this unit was mapped.

Tsaydiz Formation: The Tsaydiz Formation is roughly 150 metres thick on the ridge south of the Swannell River and at least 300 metres thick in the core of the anticline north of the Swan mineral showing. It is characterized by grey to brown limestone thinly interlayered with light grey to grey slate. Minor beds of grey, recrystallized limestone, up to several metres thick, occur throughout the section.

Espee Formation: The Espee Formation is about 150 metres thick south of the Swannell River and over 300 metres thick north of the Swan mineral showing. Extensive outcrops occur within the core of the anticline northeast of the Swan mineral claims and good exposures are found along creeks cutting the southwest side of the syncline southeast of the Swannell River. It consists of grey to white, thin to moderately bedded and platy recrystallized limestone which locally is coarsely recrystallized and dolomitic. Thin micaceous partings are occasionally present along bedding surfaces.

Stelkuz Formation: The Stelkuz Formation is some 200 to 300 metres thick and is best exposed along a ridge south of the Swannell River. It is quite variable containing both siliciclastics and minor carbonate. The basal 100 metres is composed of dark brown to brown or grey-green phyllite, argillite and calcareous argillite with rare, grey siliceous limestone layers up to 2 metres thick. There are also thin layers or very fine grained sandstone. At the top of this sequence is a honey-coloured, coarse to finely recrystallized massive to thickly bedded limestone. The phyllite immediately below this carbonate has a distinctive deep green colour as do the gritty phyllites just above it. These distinctive limestone and green phyllitic horizons are a useful local marker. The upper 100 metres of the formation begins with thin to thickly bedded quartz sandstone roughly 5 to 10 metres thick which gives way upwards to grey to dark grey phyllite.

ATAN GROUP (LOWER CAMBRIAN)

The Atan Group can locally be subdivided into two formations; the lower Mount Brown formation composed of siliciclastics and the upper Mount Kison formation made up of carbonates. The Atan section varies in thickness from 150 metres south of the Swannell River to 400 metres near the Swan mineral showings. Together with the Echo Lake group, it shows the greatest change in character north and south of the Knoll fault near the Swannell River (Figure 1-8-6).

Archaeocyathids have been recovered from the Mount Kison formation indicating an Early Cambrian age for the upper part of the Atan Group. The Mount Brown formation is similar to Lower Cambrian strata elsewhere in the Cassiar Terrane (Gabrielse, 1963).

Mount Brown formation: The Mount Brown formation ranges in thickness from 45 metres to approximately 150 metres. Near the Swan mineral showings it exhibits thicknesses and lithologies similar to those in the Osilinka River area (Figure 1-8-6): a basal grey to cream or brown quartzite or orthoquartzite up to 50 metres thick, succeeded by light green to olive green phyllite with minor light brown to brown, very thin to thin siltstone to fine sandstone layers.

The Mount Brown formation is considerably thinner immediately south of the Swannell River. The basal quartzitic unit is 5 metres thick and composed primarily of quartzose sandstone with pure orthoquartzite layers being less abundant and only 5 to 10 centimetres thick. The basal unit is succeeded by 40 metres of grey to green phyllite with traces of thin silty horizons. The contact with shales of the underlying Stelkuz Formation appears to be gradational over a distance of 5 metres.

Mount Kison formation: The Mount Kison formation is some 150 metres thick in the vicinity of the Swan mineral showings. It is composed of white to grey, finely recrystallized limestone which is locally coarsely recrystallized. Typically the unit is massive to moderately bedded featureless limestone with minor oolitic horizons in the upper part and thinner bedded sections in the lower part.

The Mount Kison formation is only 60 to 70 metres thick south of the Swannell River. It consists of a basal section of grey to dark grey, thin to thickly bedded, wavy to planar-bedded limestone. It is locally platy and has bands of alternating light and dark grey limestone. There are some very massive, coarsely recrystallized white limestone horizons in this section. Carbonate breccia or conglomerate of sedimentary origin (*i.e.*, syndepositional) are developed locally.

The top of the section is composed of grey to dark grey, thin to moderately bedded, argillaceous and graphitic, platy limestone. There are lesser massive beds of white limestone up to a metre thick. Horizons of sedimentary or primary carbonate breccia are also present.

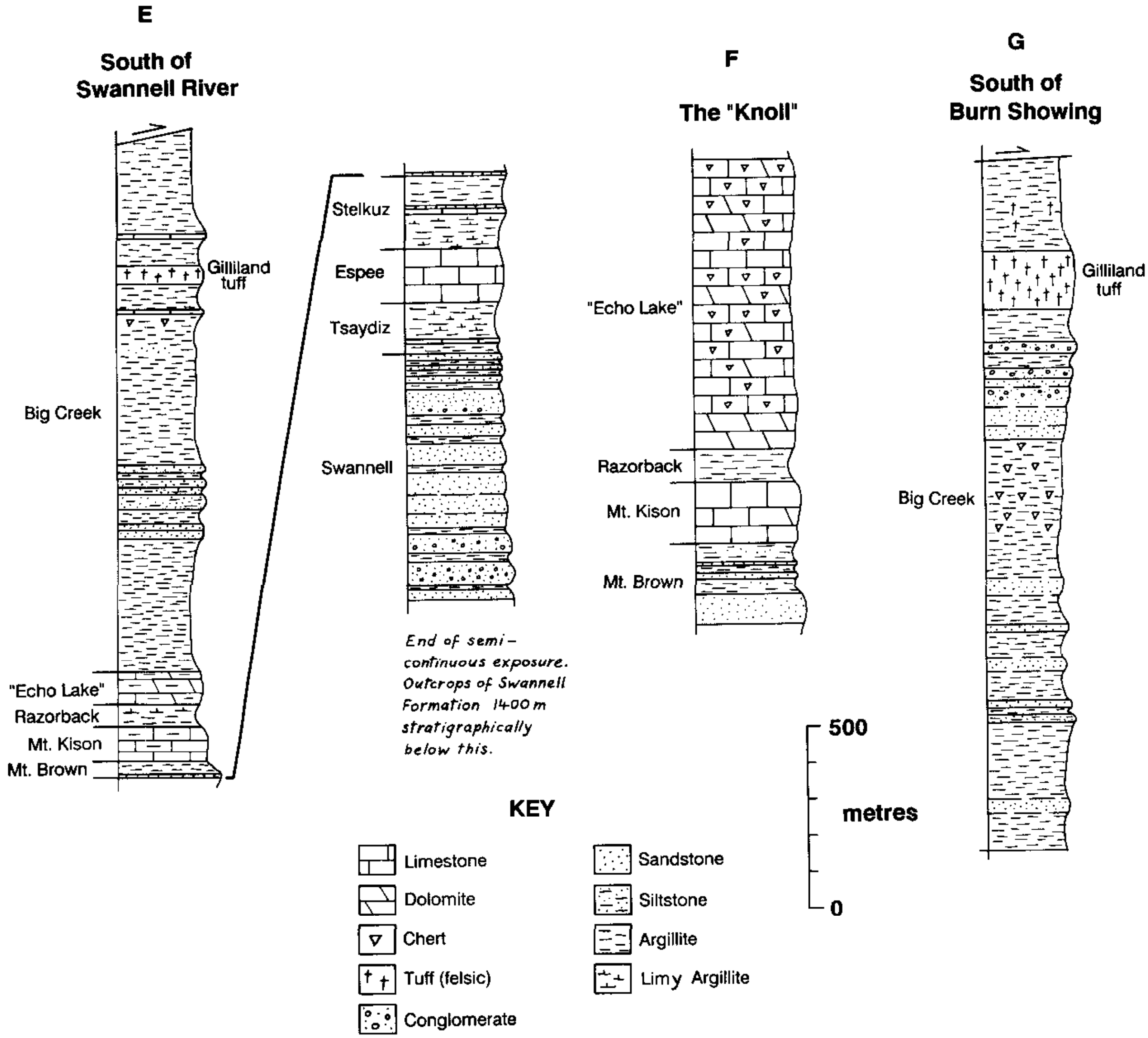

Figure 1-8-6. Stratigraphic columns of Upper Proterozoic to upper Paleozoic rocks in the northeast of the map area. Locations of columns E to G are shown in Figure 1-8-5. Columns E and F are northwest and southeast, respectively, of the Knoll fault; note the marked thinning of the Lower Cambrian (Mount Brown formation) to Devonian (Echo Lake group) succession across this fault.

Razorback Group (Cambrian to Middle Ordovician)

The Razorback group is 50 to 90 metres thick. It is poorly exposed throughout most of the map area. In the eastern part of the area it is characterized by grey to dark grey phyllite or slate in the few exposures that were observed. The best exposure is on the ridge south of the Swannell River. In this locality the basal part of the section is a green to light green phyllite with greyish phyllite in the middle part. The upper part is grey to greenish phyllite with brown limestone nodules which constitute up to 50 per cent of the rock. The uppermost 5 metres of the Razorback group is composed of silvery grey to dark grey or black phyllite with interlayers of dark grey limestone and argillaceous limestone.

No fossils were collected from this unit in the Aiken Lake map area. Lower and Middle Ordovician graptolites were recovered from the Razorback group in the Osilinka River area. The Cambrian lower age range is inferred from its position above the Atan Group and local similarities to Cambrian argillaceous facies elsewhere in the Cassiar Terrane.

Echo Lake Group (Middle Ordovician? to Lower Devonian)

Approximately 800 metres of limestone, dolomite, cherty carbonate and chert are assigned to the Echo Lake group. This unit is best exposed on a hill northwest of the Swan mineral claims. The lower part is composed of massive, buff-grey to grey dolomite and limestone. It is moderately to coarsely recrystallized and poorly to well bedded. In the upper part the carbonate is replaced by grey to pale grey cherty quartz. This chert replacement occurs along layers and in some areas affects almost 100 per cent of the rock.

Along the ridge immediately south of the Swannell River, grey to pale grey, recrystallized dolomite and dark grey-brown to black argillaceous, thinly bedded, platy limestone overlie the Razorback group. The dolomite is at the base of the succession but also occurs locally in the upper argillaceous section. The argillaceous limestone succession contains lenses of primary carbonate breccia or conglomerate and some horizons are relatively rich in crinoid ossicles, sponge spicules and shell fragments. The entire succession in this area is only 200 metres thick. These lithologies are not typical of the Echo Lake group but they are found in the expected stratigraphic position suggesting they must be an unusual facies (Plate 1-8-2). The change between this section and the typical, thick Echo Lake group appears to occur across the northeast-trending Knoll fault (Figures 1-8-5, 1-8-6) immediately northwest of the Swan mineral claims. The change is abrupt, no transitional features were seen in these units. Alternatively, the apparent thinning of the Echo Lake group in this area may be the result of a northwest-trending normal fault, but no such fault appears to be present southeast of the Knoll fault and furthermore it would have to change stratigraphic position (*i.e.*, southeast of the Knoll fault it would be stratigraphically above the Echo Lake group whereas northwest of the fault it would have to be below it). Another possible explanation for this drastic change is an abrupt facies transition northwestward towards the Swannell River. Many of the Paleozoic units show marked thinning and change in lithologic character to the northwest, suggesting a facies change. The abundance of argillaceous material points to a more basinal setting for the northern area. The Knoll fault, which forms the boundary, may be a long-lived structure which originally controlled local basin development and was later reactivated.

No definitive macrofossils were found in typical Echo Lake group rocks in the Aiken Lake area. Dark grey-brown to black argillaceous limestone and limestone south of the Swannell River, which are tentatively assigned to the Echo Lake group, have yielded crinoid and shell fragments spanning the Ordovician to Devonian time periods. In the Osilinka River area fossils suggest a Middle Ordovician to Lower Devonian age range (Ferri and Melville, in preparation, and this study).

BIG CREEK GROUP (UPPER DEVONIAN TO LOWER MISSISSIPPIAN)

The Big Creek group is perhaps the thickest unit within the Paleozoic succession of the Aiken Lake area. It is upwards of 1500 metres thick and dominated by argillaceous lithologies. This apparent thickness may be exaggerated due to tectonic thickening.

The basal 200 to 300 metres is composed of grey to blue-grey shale or argillite which locally is quite fissile. The middle part of the group contains beds of dark grey to black, chert-quartz wackes (black clastics). Typically the black clastic component of these strata is from 10 to 50 per cent but black quartzite layers are present locally. These black clastic units are usually fine to medium grained but some beds contain flattened chert grains up to several centimetres in length. It is difficult to estimate the thickness of this black clastic sequence but it is believed to be at least several hundred metres thick with clastic rocks constituting less that 30 per cent of the section.

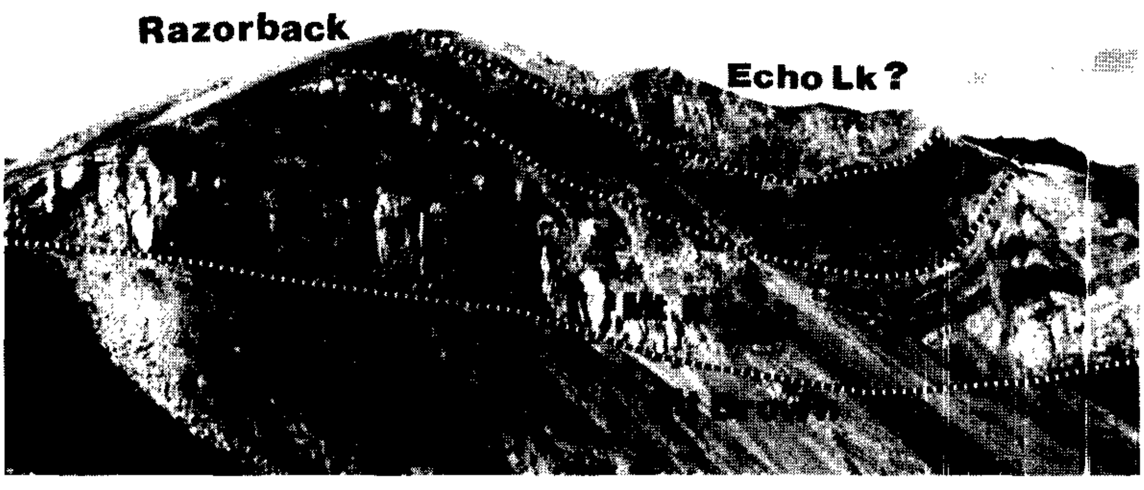

Plate 1-8-2. Looking northwest at the ridge immediately south of the lower part of the Swannell River. The viewer is standing on the Stelkuz Formation with siliciclastics of the Mount Brown formation in the immediate foreground. Mount Brown to Razorback rocks in this section are much thinner and more argillaceous than in other parts of the Cassiar Terrane in the map area. Argillaceous carbonates at the top of the hill occupy the same stratigraphic position as the Echo Lake group, but are much more argillaceous. *See* Figure 1-8-6 and text for details.

Approximately 200 to 300 metres of dark grey argillite or cherty argillite sits above the black clastic sequence. At the top of this succession are more clastics which locally contain a cobble to boulder conglomerate section 10 to 30 metres thick, with clasts of quartzite, limestone, argillite, tuff and augite-feldspar-porphyritic basalt. The restricted nature of these deposits suggests that they may be channel fills within the shale basin.

The upper part of the Big Creek group is composed predominantly of dark grey, wavy bedded argillite with minor beds of limestone and black clastics. The limestone is grey to dark grey, planar, very thin to moderately bedded and contains some very coarsely crystalline lenses. This sequence is over 50 metres thick south of the Mesilinka River. Limestone of this thickness is not typical of the Big Creek group as first described in the Nina Lake area (Ferri and Melville, 1990a; Ferri *et al.*, 1992a).

Grey, quartz±feldspar-bearing tuff, 50 to 200 metres thick is exposed towards the top of the upper part of the Big Creek group. Quartz and feldspar clasts make up less than 30 per cent of the tuff which may be strongly cleaved. The tuff is sometimes quite pyritic and rusty weathering. Argillites above, below and along strike with the tuff unit contain tuffaceous material either as thin, wispy horizons or as clasts. This tuff unit is now thought to be equivalent to the lower Mississippian Gilliland tuff of the Big Creek group described farther south in the Germansen Landing area (Ferri and Melville, in preparation) which has yielded an early Mississippian U-Pb date. There are no other age constraints for the Big Creek group in the map area except its similarities to the Upper Devonian to lower Mississippian Earn Group described elsewhere in the Cassiar Terrane (Gabrielse, 1963).

Units MPlr3 and MPlr4 (argillite and dacitic tuff divisions) assigned to the Lay Range assemblage by Ferri *et al.* (1992b), are now thought to belong to the upper part of the Big Creek group. This interpretation is based primarily on their much stronger lithological similarities and affinities. This reinterpretation includes a section of Unit MPlr3 along the Tutizika River which can be traced into the Big Creek group south of the Swannell River. The Tutizika section contains lithologies in its northwestern section which may be part of the Lower Cambrian, although the upstream section resembles the Big Creek group. As well, felsic tuff known to be within the Big Creek group is probably equivalent to the original dacitic tuff division (MPlr4) formerly included in the Lay Range assemblage.

HARPER RANCH TERRANE

Lay Range Assemblage (mississippian to permian)

Rocks of the upper Paleozoic Lay Range assemblage in the Uslika Lake area (Ferri *et al.*, 1992a, b) extend northwestwards into the present map area. Here they are well exposed in the Lay Range between Lay Creek and the Swannell River where mapping has led to a better understanding of the structure of the assemblage, and some revisions to last year's interpretation of the stratigraphy. The present work was helped considerably by unpublished maps and field notes generously made available by J.W.H. Monger of the Geological Survey of Canada.

Along the northwestern part of the Lay Range, a large northeasterly overturned anticlinal fold has been mapped (Plate 1-8-3). The core of this southeasterly plunging anticline, outcropping over a width of about 1 kilometre, contains the oldest rocks of the Lay Range assemblage, a Mississippian (?) to middle Pennsylvanian sequence of chert, tuff and clastic sedimentary rocks which are tightly folded, judging by strong cleavage development and numerous facing reversals. At the top of this sequence, referred to as the "lower sedimentary division", a fossiliferous limestone is overlain by distinctive maroon argillite and chert. This marker clearly outlines the core of the anticline on the northeastern limb but it is less easily traced on the southwest limb which is complicated by faulting.

Above the limestone - maroon argillite marker is a thick succession of tuff, agglomerate and volcanic flows, at least 2000 metres thick, referred to as the "upper mafic tuff division" which has an age range of middle Pennsylvanian to Permian. The northeast limb of the anticline is characterized by overturned strata of this division; facing indicators are less common on the right-way-up southwest limb. Southeast of this fold, in the rest of the Lay Range and the Mesilinka valley, only the upper mafic tuff division of the Lay Range assemblage is exposed.

East of Polaris Creek, the upper mafic tuff division is intruded by the Polaris Ultramafic Complex (Nixon, 1990; Nixon *et al.* (1990a, b). The contact aureole of the intrusion is commonly marked by hornfelsing and metamorphism to lower amphibolite grade, but on the northeastern margin contacts have been modified by shearing where both the Polaris Complex and the Lay Range assemblage have been thrust onto or faulted against the Big Creek group or older rocks (Nixon *et al.*, 1990a). This suggests a tectonic relationship between the Lay Range assemblage and the Cassiar Terrane; however, a primary stratigraphic relationship between them should not be ruled out.

A fault on the southwest side of the Lay Range assemblage separates it from a problematic rock unit which may be part of the Upper Triassic Takla Group. This fault zone is marked by strongly altered and fractured rocks.

Ferri *et al.* (1992a) tentatively included the dacitic tuff unit (MPlr4) and the argillite-grit-limestone unit (MPlr3) in the Lay Range assemblage, but they are now assigned to the Big Creek group.

Lower sedimentary division (Mississippian(?) to middle Pennsylvanian): The stratigraphy of the lower sedimentary division is not well defined, but it is important to recognize the probable continental derivation of some of the lithologies, in contrast to the upper volcanic-rich division. Fossil collections made by Roots (1954) probably came mostly from the this division; the oldest fossils were tentatively identified as Mississippian. The youngest unit, as defined here, is middle Pennsylvanian.

The division consists mainly of black and grey argillite and siltstone, bedded grey chert, thin-bedded feldspathic sandstone, chert-pebble conglomerate and 'grit', and less common fine to medium-grained quartzite, rhyolitic tuff, shaly or thin-bedded limestone, limy argillite and green tuffaceous rocks. The conglomerates are heterolithic, con-

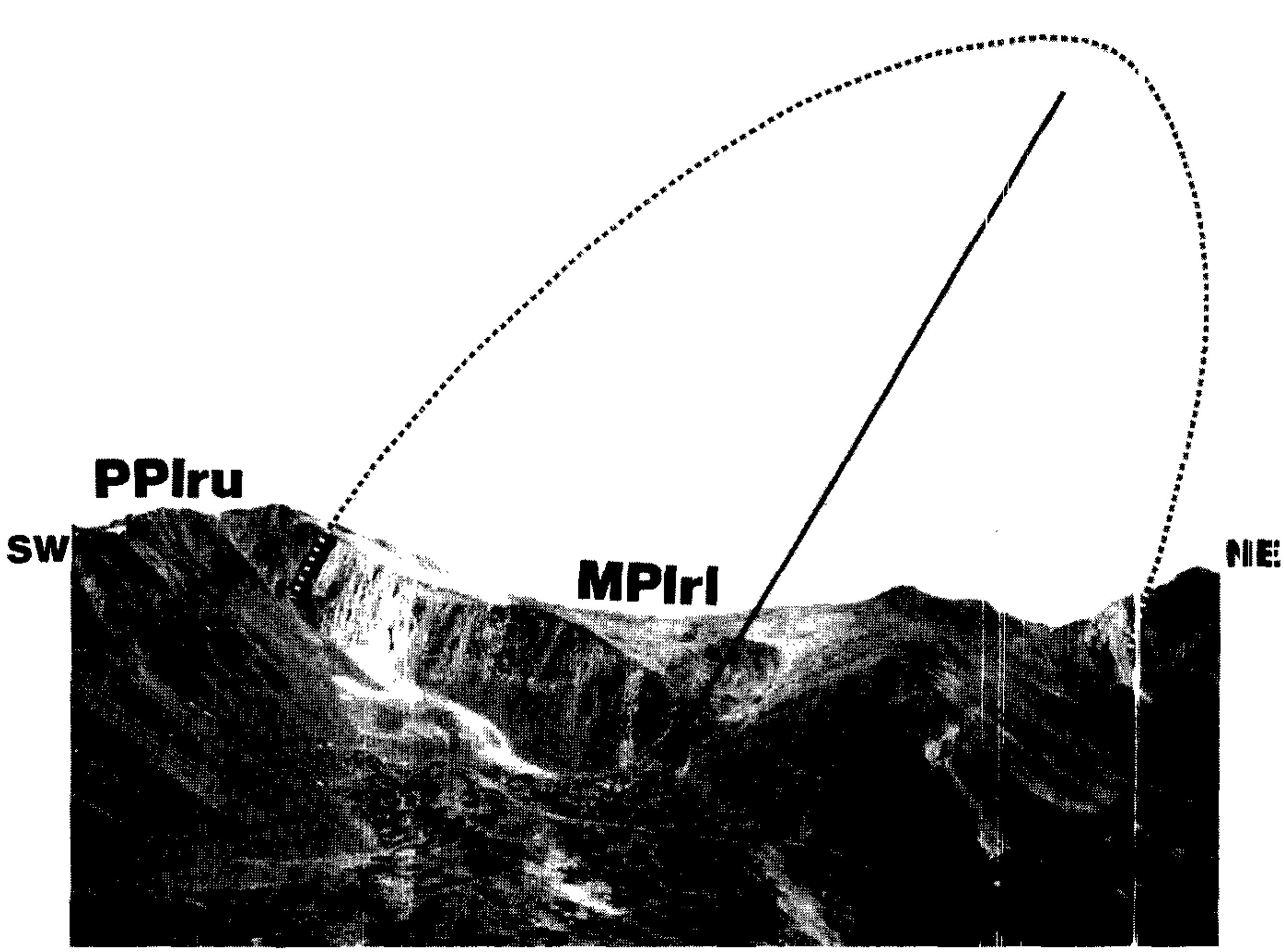

Plate 1-8-3. View to the northwest within the Lay Range, north of Polaris Creek. The mid-middle Pennsylvanian carbonate of the uppermost lower sedimentary division of the Lay Range assemblage is visible on both sides of this overturned, northeast verging fold. The viewer is from a carbonate at the nose of the fold. The distance between the carbonates is approximately 1 kilometre.

taining up to cobble-size clasts of varicoloured chert, quartz, argillite, carbonate, green tuff and clinopyroxene-phyric volcanic rock (Plate 1-8-4). A thin, coarse-grained calcareous sandstone unit contains abundant fossil material, possibly crinoids. Locally there are small felsic or dioritic intrusions, and a narrow serpentinite body is exposed along a fault zone northeast of upper Polaris Creek.

The most distinctive limestone is at the top of the division. The largest body, in the hinge zone of the anticline, is 50 metres thick, but elsewhere the limestone may be only a few metres thick, or absent. It is a grey to white, massive to thinly bedded bioclastic limestone, locally rich in colonial and solitary horn corals, crinoidal material, fusilinids and foraminifera. Fusilinids collected by J.W.H. Monger indicate a middle Pennsylvanian age (early Moscovian, Ross and Monger, 1978). The limestone is locally dolomitic, and contains green tuffaceous layers and nodular masses of red or grey chert.

An interval of thinly bedded argillite, silty argillite and jasperoidal chert, several metres thick is usually present above the limestone. Some of these rocks are strikingly maroon to red, although shades of grey are also present. This sequence is gradually succeeded by green tuffs of the upper division.

Upper mafic tuff division (middle Pennsylvanian to Permian): The Lay Range assemblage consists predominantly mafic crystal, lithic and lapilli tuffs, agglomerate and volcanic flows, with subordinate interbedded green to grey argillite, siltstone, volcanic wacke and conglomerate, chert, limy siltstone and limestone, all of which comprise the upper mafic tuff division. One limestone unit, mapped near the base of this division on the southwestern limb of the anticline, contains middle Pennsylvanian fusilinids (late Moscovian, Ross and Monger, 1978), slightly younger than the limestone marker unit at the top of the lower sedimentary division. Permian conodonts were recovered from limy siltstone within mafic tuffs much higher in the division, in the Uslika Lake area (M.J. Orchard, personal communication, 1991; Ferri *et al.*, 1992a).

The volcanics are lithologically similar to the Upper Triassic Takla Group, but are distinguished in the field by their deeper green colour due to epidote, greater induration and stronger cleavage, and by the presence of quartz

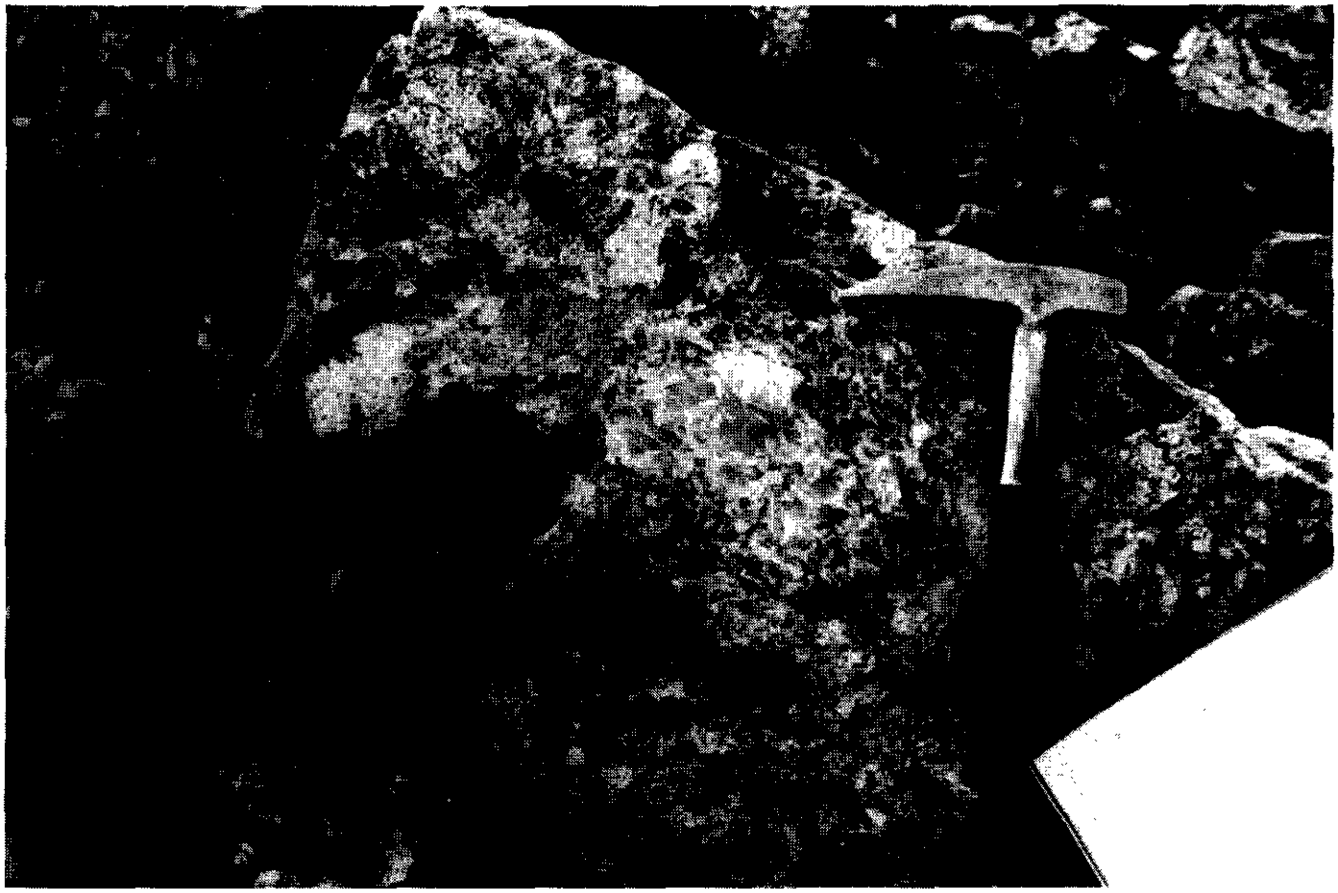

Plate 1-8-4. Polymict conglomerate within the lower sedimentary division of the Lay Range assemblage. Large chert and carbonate clasts are visible. This conglomerate is much greener and more indurated than the younger maroon conglomerate illustrated by Plate 1-8-7.

(although rare) in coarser tuffs. The tuffs are bedded in units from several metres thick to centimetre-scale graded beds and fine laminations. Volcanic flows, locally pillowed, commonly have clinopyroxene and feldspar phenocrysts, and may be vesicular and amygdaloidal. They have the composition of basaltic andesite, and geochemical characteristics transitional between an island-arc and an ocean-floor origin. Rocks in this division, particularly the volcanics, are locally maroon, and maroon fragments are common in tuffs. Small felsic intrusions and gabbro occur in places.

QUESNEL TERRANE

TAKLA GROUP (UPPER TRIASSIC TO LOWER JURASSIC)

The Takla Group in the Aiken Lake area can be subdivided into the Plughat Mountain formation and the maroon tuff unit (Unit lJuTrt, Ferri *et al.*, 1992b). These rocks are best exposed in the mountains southwest of Lay Creek and the Mesilinka River. They are a continuation of units described in the Uslika Lake area by Ferri *et al.*, (1992a, b). Plughat Mountain rocks are believed to be restricted to the Upper Triassic. Roots (1954) collected Upper Triassic faunas from Plughat rocks near Granite Basin and Carnian conodonts were recovered from limy horizons in the lower part of the Plughat formation near Uslika Lake. The maroon tuff unit is thought to contain both Upper Triassic and Lower Jurassic rocks as it is equivalent to a unit of these ages to the southeast (Unit lJuTrt, Ferri *et al.*, 1992b). The Takla Group is bounded on its northeast side by the strike-slip Lay Range fault (Wheeler and McFeely, 1991) along the Lay Creek - Mesilinka River drainages, and is intruded by the Hogem intrusive complex to the southwest. Takla rocks are hornfelsed and recrystallized along the margin of the Hogem intrusive complex. Calcareous lithologies may be altered to skarn and traces of copper are very common along the contact.

Plughat Mountain formation: The Plughat Mountain formation is at least 4000 metres thick and is composed of mafic tuffs, agglomerates and lesser tuffaceous sediments. Two broad subdivisions of the formation were delineated by Ferri *et al.* (1992 a, b) in the Uslika Lake area to the south: a lower, dominantly tuffaceous sequence which grades laterally and upwards into a thick and extensive upper agglomeratic succession. The Plughat Mountain formation in the present map area, however, is dominated by tuffaceous lithologies which in places comprise the entire thickness of the exposed Takla succession. Thick accumulations of agglomerate were seen only in the southern and northern parts of the map area. These pinch out laterally into coarse tuffs over a distance of a few kilometres. Kilometre-thick tongues of agglomerate (as seen on Mount Elsie) are also present within the tuffaceous sequence but also quickly pinch out.

Major lateral facies variations also occur within the tuffaceous rocks. Coarse volcaniclastics in the syncline south of Tutizzi Lake quickly pinch out northward, along strike, into massive sections of coarse crystal-ash and lapilli tuff. These coarse tuffs continue to change in character northward, becoming finer grained, more distinctly bedded and containing sections of tuffaceous siltstone and argillite. A very similar transition is seen in the Granite Basin area northwest of Aiken Lake.

The absence of a clear tuff to agglomerate transition or any other marker within the Plughat Mountain formation means that the generalized stratigraphic columns north of Tutizzi Lake (Figure 1-8-7) cannot be correlated with any confidence. Nevertheless, given their en echelon position and the predominantly westerly dip, they can be projected into one another to suggest a total stratigraphic thickness in excess of 11 kilometres.

The lower part of the Plughat Mountain formation is dominated by blue-grey to grey, very fine to coarse crystal-ash tuffs to coarse lapilli tuffs with lesser agglomerate, tuffaceous siltstone, argillite and limestone. Layering tends to be massive to thickly bedded but finer grained sections of tuff display thinner bedding (Plate 1-8-5). Finer tuff sections are dominated by feldspar crystal fragments with subordinate pyroxene. Volcanic clasts are augite and plagioclase phyric, though locally carbonate fragments are prominent. Tuffs and agglomerates in this section locally have a calcareous matrix.

The lower tuff sequence contains minor sections of finely bedded tuffaceous siltstone, siltstone, argillite, calcareous argillite and tuff, and limestone ranging from a few metres to 50 metres in thickness. These beds are rare in the upper and eastern part of the tuff section but become more prominent eastward and downward in the section. The lowest part of the tuffaceous section, exposed on the north-facing slopes above the Mesilinka River, is dominated by well-bedded, very fine grained crystal-ash tuffs, tuffaceous siltstones, siltstones, argillites, calcareous argillites and limestones. Sections of predominantly sedimentary lithologies up to 200 metres thick can be mapped over strike lengths of several kilometres within the fine tuffs.

Massive agglomerate and subordinate coarse lapilli tuff to crystal tuff several kilometres thick, generally rest above the tuffaceous sequence in the map area (Plate 1-8-6). Massive agglomerate interfingers with the tuffaceous section and is also present within it. The agglomeratic sequence is sometimes interrupted by very thin beds of siltstone, argillite and limestone, as seen west of Granite Basin. The agglomerate is typically monolithic being composed of augite porphyry and sometimes feldspar porphyry clasts. Heterolithic agglomerate with clasts of plagioclase and augite porphyry and sometimes plagioclase porphyry as well as intrusive feldspar porphyry is exposed on Mount Elsie. Feldspar porphyry agglomerate crops out north of Granite Basin. It is above a section of distinctive augite feldspar porphyry agglomerate with abundant carbonate clasts up to 30 centimetres in size. The feldspar porphyry agglomerate appears to grade along strike into typical augite feldspar porphyry.

Maroon tuff unit: A fault-bounded package of maroon to green volcanics and minor sediments outcrops along the eastern boundary of the Takla Group. It is best exposed on a northwest-trending ridge between the Mesilinka and Tutizika rivers. The stratigraphy and thickness of this unit is not known but regional strikes and dips indicate it must be in the order of several kilometres thick.

The unit is characterized by maroon to green basaltic agglomerate, lapilli to ash tuffs and massive flows. The maroon colour is more dominant toward the south. Flows and coarse clastic material are composed of amygdaloidal hornblende or pyroxene±feldspar porphyry. Dark grey to grey argillite is a minor constituent. Rare heterolithic pebble conglomerate with clasts of grey chert, black argillite, maroon feldspar porphyry, quartz and green volcanics is found along the southwestern boundary of the unit just north of the Tutizika River. This conglomerate is similar to younger pebble conglomerate found along the margins of this unit (*see* section below).

Plate 1-8-5. Well-bedded tuffs, tuffaceous siltstone and argillites near the top of Mount Elsie. This sequence is approximately 50 metres thick and lies within a thick section of agglomerate. These tuffs are more typical of the lower parts of the Takla Group.

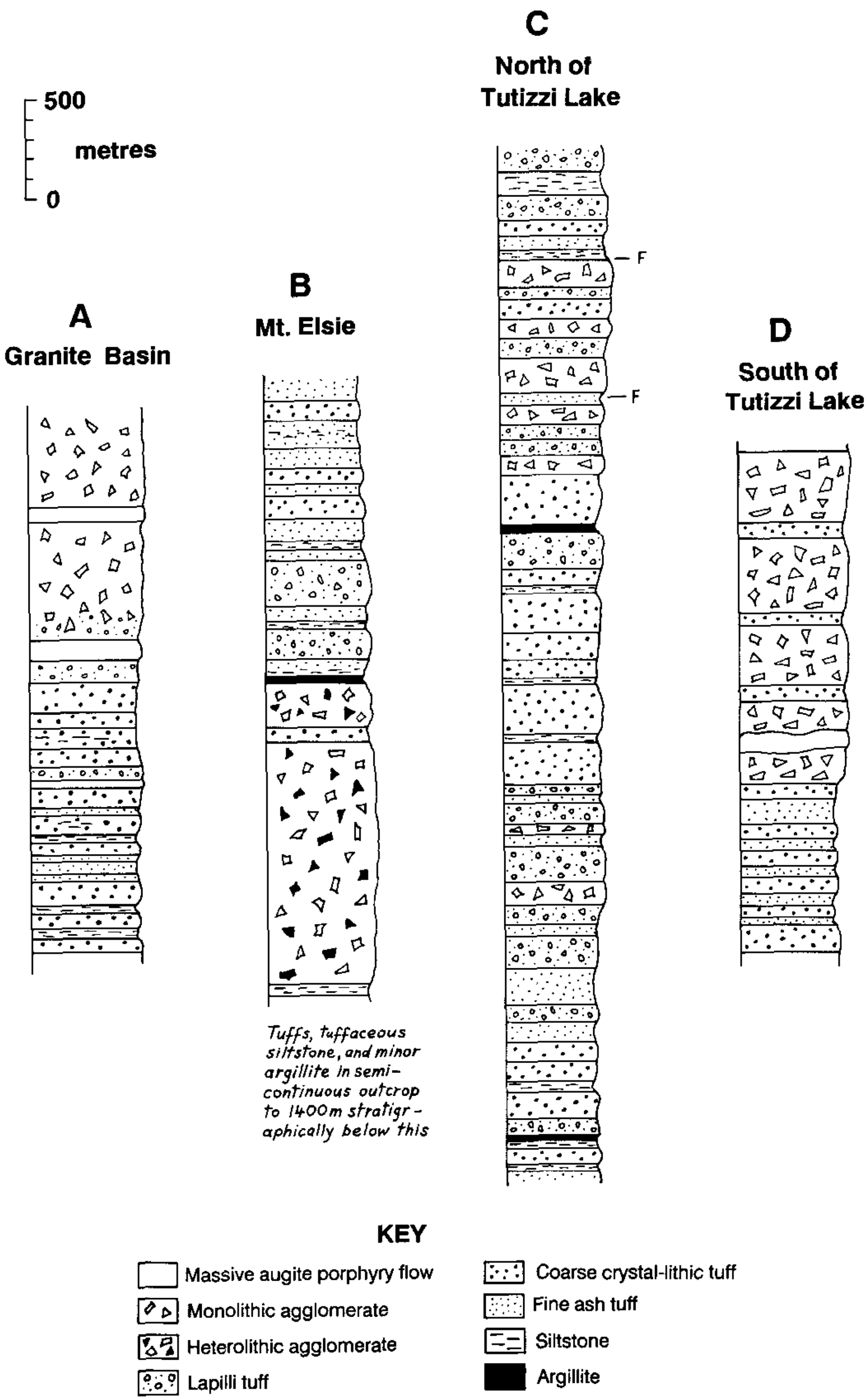

Figure 1-8-7. Representative stratigraphic columns of Takla Group rocks. Location of column A to D is shown in Figure 1-8-5. No common stratigraphic datum is implied. Note the predominance of tuffaceous lithologies over agglomeratic ones.

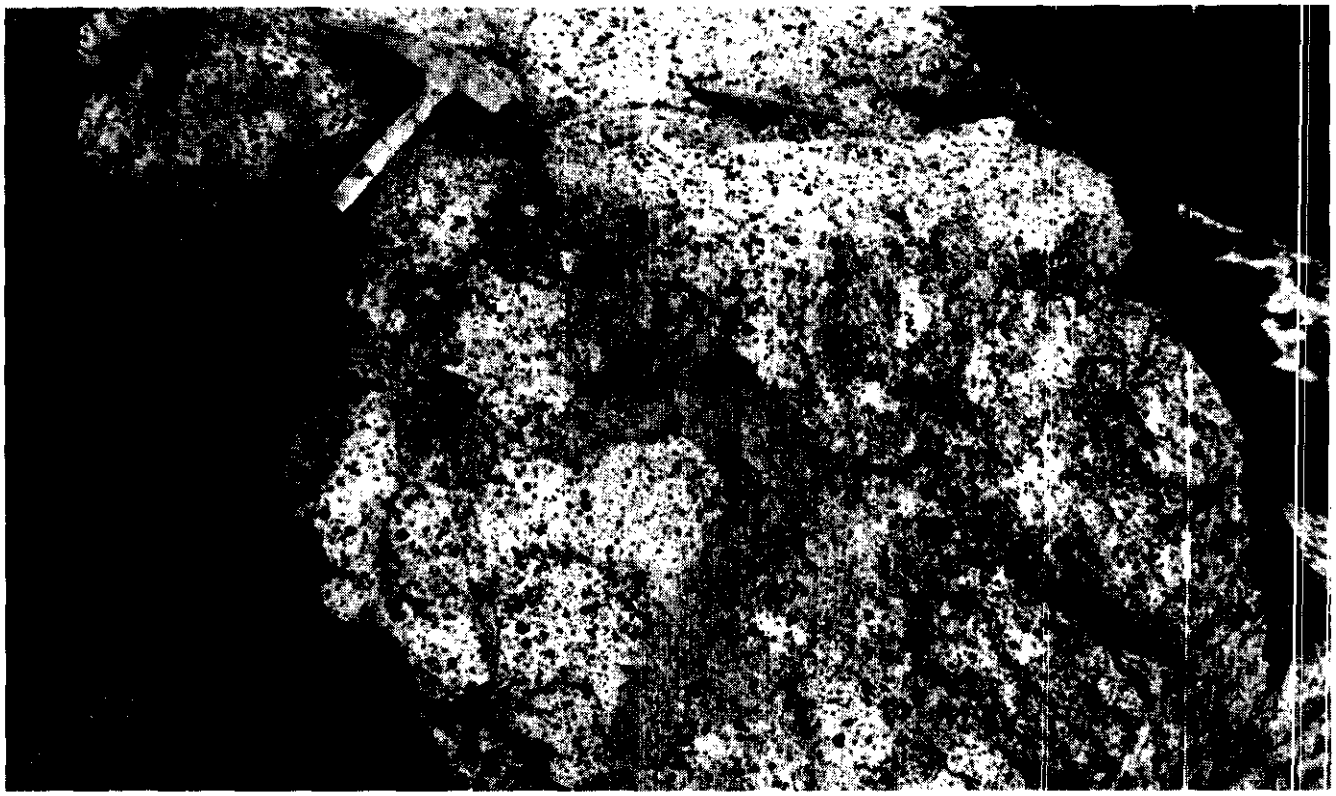

Plate 1-8-6. Augite-plagioclase-phyric agglomerate west of Granite Basin. Massive agglomerate, like this is more prevalent within the upper part of the Takla Group.

PROBLEMATIC UNIT (PALEOZOIC OR MESOZOIC)

A fault-bounded section of steeply dipping argillites, tuffs and minor coarse volcaniclastics outcrops on the ridge between Lay and Polaris creeks. The southwestern margin of this package is the Lay Range fault along Lay Creek. The character of the fault on the northeastern margin is not presently known though it *appears* to be less significant than the southwestern fault zone.

The overall appearance of these tuffs and sediments is very similar to the lower part of the Takla Group southwest of the Mesilinka River. The blue-grey to grey colour of the tuffs, lack of penetrative cleavage in finer grained lithologies, lack of continentally derived material and overall poorer induration indicate stronger affinities with the Takla Group than with the Lay Range assemblage. However, we believe that the lithologic similarities alone do not justify the relocation of a terrane boundary. More data, in the form of fossil ages, are required before these rocks can be definitely assigned to either the Takla Group or the Lay Range assemblage.

Rocks within this package are dominated by grey to blue-grey, very fine to coarse crystal-ash tuffs, tuffaceous siltstone, dark grey to black graphitic argillite, calcareous argillite and minor limestone. Lesser augite$\pm$plagioclase porphyry lapilli tuff and agglomerate are present within the northern part of the unit. These coarser volcaniclastics may be a fault sliver of Takla Group rocks. Layering is predominantly very thin to thickly bedded in the finer grained lithologies and becomes more massive to the north within the lapilli tuffs. These rocks form a panel which generally is upright and steeply dipping to the southwest though locally bedding is overturned to the southwest.

OVERLAP ASSEMBLAGES

Several exposures of younger conglomerate, sandstone and siltstone are found primarily along the fault boundaries between terranes. Conglomerate is also exposed in the Lay Range. Many of these packages are too small to display on the map in Figure 1-8-5 but their presence may denote significant fault zones. Several varieties of these clastics are present but none have been dated, although their tectonostratigraphic position and overall similarity to Late Jurassic(?) to Tertiary conglomerate in the Uslika Lake area (Ferri *et al.*, 1992b) suggests a correlation.

MAROON CONGLOMERATE (CRETACEOUS TO TERTIARY)

Maroon pebble to boulder conglomerate is exposed in at least two places in the Lay Range north of Polaris Creek. The northern body forms a long, discontinuous outcrop which varies from 300 metres to less than 100 metres wide. It occurs within a high-angle strike-slip fault zone in its northern part where it is tectonically juxtaposed against strongly sheared serpentinite and volcanics of the Lay Range assemblage. In its southern part an unconformable relationship with Lay Range tuffs was found along parts of its contact.

Another body of conglomerate to the southeast is roughly 1 square kilometre in area and more brown than maroon. It sits unconformably above rocks of the Lay Range assemblage although locally this contact is faulted.

The maroon conglomerate is composed of well-rounded clasts of quartzite, chert, argillite, phyllite, green tuff, amphibolite gneiss, schist and rare coralline limestone set in a coarse sandy matrix (Plate 1-8-7). This unit appears very similar to the Uslika Formation of the Uslika Lake area (Ferri *et al.*, 1992a, b; Roots, 1954) which has a poorly constrained age of Late Jurassic to Early Tertiary. The most obvious source of the metamorphic clasts is the Wolverine Metamorphic Complex. Unroofing and cooling of this complex appears to have occurred rapidly in the Late Cretaceous to Early Tertiary. This is substantiated by the presence of metamorphic clasts in the nearby Upper Cretaceous to Lower Tertiary Sifton Formation (Gabrielse, 1975; Roots, 1954) and from K-Ar cooling ages in these metamorphic rocks (Ferri and Melville, in preparation). These considerations help to further constrain the age of the conglomerate to Late Cretaceous to Early Tertiary.

Conglomerate (Lower Cretaceous?)

Pebble to cobble conglomerate is exposed on either side of the maroon tuff unit south of the Mesilinka River. Most of these bodies are strongly sheared and indicates involvement in the shear zone in which they are found. Three areas are underlain by these younger clastics but their general similarity suggests they are related. The largest body, at the northeastern contact of the maroon tuff unit, is associated with maroon to black feldspathic sandstones and mudstones with coaly fragments and plant fossils. Clasts are composed of quartzite, chert, green tuff, siltstone and argillite. The two bodies to the south contain pebbles of only quartzite and chert.

The age of these conglomerate bodies is not known as no diagnostic fossils were found. Their location suggests that they may have filled a depression produced by erosion of softer rock along the fault zone or that they have been preserved in grabens along the fault zone. The maroon to black sandstone and siltstone along the northeastern boundary of the maroon tuff unit bears some resemblance to Early Cretaceous sediments in the Uslika Lake area (Ferri *et al.*, 1992 a, b).

INTRUSIVE ROCKS

Hogem Intrusive Complex and Related Intrusions (Late Triassic to Middle Jurassic, Cretaceous)

The Hogem intrusive complex is exposed in the southeastern part of the map area and intrudes rocks of the Takla

Plate 1-8-7. Maroon polymict conglomerate in the Lay Range. The age of this unit is inferred to be Late Cretaceous to Early Tertiary based on clast composition and its similarities to younger conglomerate farther south. It is far less indurated than conglomerate of the Lay Range assemblage (Plate 1-8-4).

Group. It is a multiphase complex with latest Triassic to Middle Jurassic alkaline phases and Cretaceous calcalkaline bodies (Garnett, 1978). Only a cursory examination of its margin was conducted during the 1992 field season.

The contact with the Takla Group is commonly an intrusive breccia. Takla rocks are hornfelsed and coarsely recrystallized for up to a kilometre away from the Hogem contact. Minor amounts of copper are commonly found along this contact.

Hogem rocks in the southern part of the map area are alkaline in composition and made up of tan to pink, medium to coarsely crystalline quartz monzonite to monzodiorite or syenite to monzosyenite with hornblende and/or biotite as accessories. Mottled pink and white, coarsely crystalline granodiorite crops out south of Abraham Creek. Coarsely crystalline gabbro is exposed along the ridges between Abraham Creek and the Mesilinka River. This body may be related to mafic and ultramafic intrusions along the margin of the Hogem complex (Irvine, 1974, 1976). Tan to pink, medium to coarsely crystalline granite to granodiorite, containing chloritized hornblende as an accessory, is exposed north of the Mesilinka River.

Two lenticular bodies of grey to green feldspar porphyry and related diorite are found north of the Mesilinka River and south of Kliyul Creek. They are locally rusty weathering to gossanous due to the presence of 1 to 5 per cent disseminated pyrite.

Hogem rocks are cut by numerous dikes of pink aplite or syenomonzonite from several centimetres to several metres in thickness. The relationship of these dikes to other bodies in the Hogem intrusive complex is not known. The Takla Group volcanics are also cut by numerous small dikes or irregular bodies of coarse feldspar porphyry. These rocks are characterized by feldspar phenocrysts up to several centimetres in length. The abundance and size of the dikes decreases away from the Hogem contact suggesting a genetic link to the complex.

One, and possibly two, bodies of poorly exposed grey, magnetic, hornblende-bearing monzonite intrude the problematic unit and the nearby maroon tuff unit north of the Mesilinka River. Argillites and fine tuffs in these packages are hornfelsed and pyritized. The monzonite is cut by diorite or gabbro dikes up to 1 metre wide.

Polaris Ultramafic Complex and Related Intrusions (Early Jurassic)

The Lay Range assemblage is intruded by a large composite Alaskan-type ultramafic body called the Polaris Ultramafic Complex, covering an area of some 40 square kilometres. This transgressive sill-like body is composed of varying amounts of dunite, pyroxenite, hornblendite, wehrlite and gabbro, and is of late Early Jurassic age (G.T. Nixon personal communication, 1992). Only its margins were examined as it was recently mapped in detail by Nixon *et al.* (1989, 1990a, b; Nixon and Hammack, in preparation). The reader is referred to these publications for further details.

Mafic-Ultramafic Unit (Early Jurassic or Older?)

A composite body of gabbro, hornblendite, pyroxenite, orthopyroxenite and peridotite, over 20 kilometres long and 2 to 10 kilometres wide, intrudes the Takla Group near the Hogem contact. These rocks were examined in some detail by Irvine (1974, 1976) who described at least two separate bodies. Field data from this year's work, in conjunction with published aeromagnetic maps of the area, suggest that Irvine's two bodies are actually one. The aeromagnetic signature of the gabbro body south of Tutizzi Lake suggests it is related to this mafic-ultramafic unit. The age of this unit is not directly known. If it is an Alaskan-type ultramafic body and related to the nearby Polaris Complex then a latest Early Jurassic age is postulated (G.T. Nixon, personnel communication, 1992). Alternatively if these bodies are related to mafic phases of the Hogem intrusive complex they may be as old as the latest Triassic (Garnett, 1978).

Very coarse to finely crystalline, multiphase hornblende gabbro is the most dominant lithology in the northern part of the large intrusion. The most mafic lithologies (peridotite, hornblendite and orthopyroxenite) form a long sinuous body along its western margin. Hogem rocks appear to cut this ultramafic intrusion.

A small body of dark green, very fine to coarsely crystalline gabbro intrudes the Takla Group south of the Mesilinka River, and is most likely related to the mafic-ultramafic unit.

Structure and Metamorphism

Structural style and metamorphic grade are quite diverse in the Aiken Lake map area due to the varied terranes and rock packages present. Broad open folds and subgreenschist grade metamorphism characterizes the Quesnel Terrane. The intensity of deformation and metamorphism is higher to the east in the Harper Ranch Terrane, and is most intense in rocks of the Cassiar Terrane where polyphase deformation is associated with metamorphism up to garnet grade.

Terranes are bounded and cut by major faults. The most important fault zone in the map area is the Lay Range fault (Wheeler and McFeely, 1991) a steep, northwest-trending strike-slip structure which trends roughly parallel to the Lay Creek valley. In this area strongly sheared and crumpled tuffs, tuffaceous siltstones and argillites of the Takla Group and the problematic unit are juxtaposed across an anastamosing fault zone about 1 kilometre in width. The fault zone is exposed on the northeast side of the upper part of Lay Creek; southeastward, it is covered by alluvium in the Mesilinka River valley but we believe it merges with the wide and intense shear zone mapped on the southwest side of the maroon volcanic package of the Takla Group. Several other parallel structures are found within the Takla Group and problematic unit.

The northeastern boundary of the problematic unit is a fault zone we believe to be related to the Lay Range fault. Although it is not as wide, and no kinematic indicators were observed, its steep dip and trend parallel to the Lay Range fault suggest they are genetically linked. This fault also merges with shear zones south of the Mesilinka River valley which separate the maroon volcanic unit from tuffs of the Lay Range assemblage.

High-angle, strike-slip faults were also observed within the Lay Range assemblage. One, along the southwest flank of the lower sedimentary division, is marked by sheared serpentinite. Younger maroon Uslika-like conglomerate is also exposed within this fault zone.

We believe the various northeast-trending fault zones described here join structures mapped by Ferri *et al.* (1992a, b) in the Uslika Lake area. These fault zones ultimately connect with structures described by Nelson *et al.* (1993, this volume) along Discovery Creek. The Lay Range - Uslika Lake - Discovery Creek faults form a parallel structure en echelon with the Manson fault zone.

A major northeast-verging, ductile shear zone is exposed along the northeast contact of the Polaris Ultramafic Complex. This zone is upwards of 75 metres thick within peripheral gabbro of the complex and dips steeply to the southwest. A similar thickness of sheared argillite may be present within adjacent rocks of the Big Creek group but this is difficult to demonstrate due to the fine-grained, monotonous nature of these rocks. This shear zone was observed at several localities and was mapped by Nixon *et al.* (1989, 1990a, b). We believe it extends to the southeastern end of the Polaris Complex.

This shear zone represents the boundary between the Harper Ranch and the Cassiar terranes in this area as the Polaris Ultramafic Complex intrudes the Lay Range assemblage (Harper Ranch Terrane). To the southeast, the shear zone does not wrap around the southern end of the complex, but presumably continues southeastwards, separating the upper mafic tuff division of the Lay Range assemblage from the Big Creek group of the Cassiar Terrane. The absence of the lower sedimentary division anywhere between them supports the continuation of a fault along this contact, but without direct structural evidence for this, an unconformity is not precluded: it is possible that the lower sedimentary division was not deposited, or that is was eroded away between Big Creek and upper mafic tuff deposition. However, a fault is more likely. This contact would continue south of the present map area and onto the Uslika map sheet (Ferri *et al.*, 1992b) where the upper mafic tuff division (Unit MPlr2) is next to Unit MPlr3, now placed in the Big Creek group. Sheared tuffs of the upper mafic tuff division were mapped along this boundary south of the Tutizika River suggesting a fault contact between the two packages.

Normal faults are recognized mostly within Cassiar rocks. Two generations of normal faults have been identified; northwest-trending, southwest-side-down faults and later northeast-trending, southeast-side-down faults. The northeast-trending Knoll fault south of the Swannell River has considerable displacement as it juxtaposes garnet-grade rocks of the Swannell Formation against lower greenschist rocks of the Echo Lake group. Stratigraphic thicknesses and lithologic characteristics of units change across the fault suggesting that it may be a reactivated older structure which controlled basin development in the area. This fault also displaces the major shear zone at the base of the Polaris Complex.

The northwest-trending fault cut by the Knoll fault has not been recognized to the northeast of Knoll fault, although it may be hidden within monotonous shales of the Big Creek group.

Structural attitudes within Quesnel rocks are relatively simple in comparison to the other rock packages. Bedding dips typically southwest to northwest, with variations outlining broad folds, as seen south of Tutizika River. The only deviance from this is along the northeast margin of the Quesnel Terrane where finer grained units define tighter folding. One such area is south of the Mesilinka River and southwest of the maroon tuff unit. At this locality, fine ash tuffs, tuffaceous sediments and argillites define steep, tight folding which on a macroscopic scale appears to be chevron-like. Northward, along this fault zone, bedding is steep to overturned. This may reflect its proximity to the fault zone.

Northeasterly bedding trends common in the Takla Group in the central and northern parts of the map area are different from the northwest-trending attitudes seen in the other terranes, which are more typical of the region. The regional significance of this is not yet resolved.

Folds within the problematic unit are upright or overturned to the northeast. Macroscopic fold structures were not observed directly and are inferred from dip reversals and overturned bedding.

The Lay Range assemblage locally contains a penetrative fabric or cleavage within the finer grained lithologies. The trace of the carbonate unit at the top of the lower sedimentary division outlines a megascopic southwest-plunging, northeast-verging, overturned fold which must represent the overall structural style of the package. Bedding reversals in the upper mafic tuff unit suggest the presence of similar megascopic folds but the monotonous nature of the tuffs precludes their accurate delineation.

In general, Cassiar rocks form a southwest-dipping panel. This is modified by several large-scale broad folds (F_2?) in the northeastern part of the map. The vergence of these megascopic folds is not known but Roots (1954) and Bellefontaine (1990) indicate that these structures are southwest verging. Mesoscopic folds (F_1) which have axial planes parallel to the dominant cleavage or foliation (S_1) show northeast vergence. This foliation is subparallel to compositional layering (S_0). The upright nature of the megascopic folds suggests that they are unrelated to the mesoscopic, northeast-verging structures. The dominant foliation in these rocks is cut by several sets of crenulations some of which are subparallel to S_1 and others which cut S_1 or S_0 at high angles.

Takla Group volcanics are characterized by sub-greenschist grade metamorphism at lower grade than rocks of the Lay Range assemblage. The more intense green to apple green colour of Lay Range volcanics results from the greater abundance of epidote which may be a reflection of the higher metamorphic grade (lower greenschist). The greater induration of Lay Range rocks is also a function of increased metamorphic grade.

Cassiar rocks display the most penetrative deformation and highest grade of metamorphism in the map area. Metamorphic grade along the Swannell River is upper greenschist in the lower parts of the Swannell Formation. High-grade assemblages consist of garnet±chloritoid-biotite-muscovite with the appearance of garnet and biotite essentially coinciding. Garnet porphyroblasts are idioblastic and appear to overgrow both the main foliation and a later crenulation cleavage, although in some areas the garnet porphyroblasts deflect the crenulation cleavage planes. This suggests several generations of crenulation cleavage formation. Garnet and biotite pophyroblasts are locally chloritized.

ECONOMIC GEOLOGY

A variety of mineral deposit styles are represented in the Aiken Lake and Osilinka River map areas. These include porphyry copper-gold, carbonate-hosted lead-zinc-barite± precious metals, and various vein deposits. Occurrences of lesser importance include ultramafic-hosted chromite, skarns and industrial minerals. The reader is referred to Table 1-8-1 for a brief description of the various occurrences in the map area.

Takla rocks host a large number of copper occurrences (some with associated gold) in both porphyry-style systems and hydrothermal veins often associated with shearing. At some occurrences there seems to be a direct correlation between copper mineralization and ultramafic dikes or sills that intrude the Takla volcanics. Porphyry mineralization is related to the syenite-monzonite-diorite-granitic-intrusive phases which comprise the Hogem intrusive complex. The Porphyry Creek and Granite Basin occurrences in the Aiken Lake map area are examples of this style of mineralization.

The Porphyry Creek occurrence, located on the extreme western boundary of the Aiken Lake map area, is the largest known porphyry system in the map area. Takla volcanics, sediments and limestones are intruded by diorite, quartz diorite, granodiorite and quartz monzonite of the Hogem intrusive complex and pyroxenite and gabbro of an ultramafic body. Sulphides include chalcopyrite, rare chalcocite and bornite together with native gold, galena, sphalerite and molybdenite occurring as disseminations, fracture fillings and in shears. Higher concentrations of gold and base metals are associated with late-stage intrusive activity. At least two complex mineralized systems are present on the Porphyry Creek property. The first is a calcalkaline porphyry molybdenum system with mineralization within a tabular, potassically altered and zoned granodiorite intrusion surrounded by a weak copper±tungsten halo. The second system is related to an intrusive breccia peripheral to the granodiorite stock and has potential for copper-gold mineralization of possible alkaline affinities (Grexton and Roberts, 1991).

There are many small copper (±gold±molybdenum) occurrences throughout Takla Group rocks (*see* Table 1-8-1) that are commonly related to an intrusive body and/or localized hydrothermal veining (usually quartz or ankerite). Mineralization is also frequently found along fractures and in veins within mafic to ultramafic rocks of an ultramafic body.

Mineralization commonly consists of chalcopyrite, malachite and azurite±magnetite±molybdenite±specularite± galena±sphalerite in quartz and/or carbonate (commonly ankerite) veins. The amount of mineralization varies from a few specks of malachite to strongly mineralized quartz-carbonate vein systems several metres wide.

Carbonate-hosted lead-zinc occurrences occur within each of the various Paleozoic and Upper Proterozoic calcareous lithologies. Most showings appear to be stratabound replacements, although some are interpreted as stratiform (Ferri and Melville, in preparation), or related to hydrothermal activity, with remobilization and deposition in veins. Examples of carbonate-hosted lead-zinc occurrences include the PAR and Childhood showings in the Osilinka River area and the Swan, Rain and Crag showings in the Aiken Lake map area.

Recent mineral exploration in the Osilinka River area has centred on the PAR claims held by Cominco Exploration Limited. Lead, zinc, gold and silver mineralization with associated barite is found within and associated with the Lower Cambrian Mount Kison formation limestone, Cambrian to Middle Ordovician Razorback group limy shales to argillite, Ordovician to Lower Devonian Echo Lake dolostone and Middle Devonian Otter Lakes limestone. Trenching on the property in 1991 revealed thin lenses (less than 0.4 m) of 60 to 80 per cent sulphide rock intercalated with shales, phyllites and dolomite boudins of the Razorback group. Best assay results reported from trenching were: 6.7 per cent lead and 2.5 per cent zinc over 4.0 metres; 1.1 per cent lead and 3.2 per cent zinc over 18.0 metres; 6.1 per cent lead and 3.4 per cent zinc over 1.0 metre (Craig, 1991).

The Childhood Dream prospect is located north of the Osilinka River and east of Beveley mountain. Hosted in both primary and secondary breccia of the Echo Lake group (as described earlier in this article), it consists of massive to coarse-grained pyrite with disseminated galena and sphalerite. There are two exploration adits on the property with the best assay reported from a 1.8-metre chip sample returning 0.34 gram per tonne gold, 24.0 grams per tonne silver, 2.6 per cent lead and 11.2 per cent zinc (Lay, 1931).

Hydrothermal veining and mineralization are also attributed to faulting and shearing along the Lay Range fault. Occurrences related to the Lay Range fault include the Polaris and Polaris Zinc showings hosted by sheared volcanics and sediments of the Takla Group and possibly related to small diorite porphyry and quartz monzonite stocks mapped in the area. Mineralization consists of quartz-calcite veins with disseminated pyrite, arsenopyrite and pyrrhotite together with thick lenses of massive pyrite, pyrrhotite and chalcopyrite, and fracture coatings of chalcopyrite and molybdenite. The Jupiter and LCF prospects consist of quartz-carbonate-veined rock within the Lay Range fault zone.

The presence of skarn mineralization in some of the numerous limestone horizons within the Takla Group suggests a strong potential for similar mineralization along its contact with the Hogem intrusive complex.

TABLE 1-8-1
TABLE OF MINERAL OCCURRENCES IN THE AIKEN LAKE AND OSILINKA RIVER AREAS

MAP NUMBER	STYLE OF MINERALIZATION	MINFILE NUMBER	OCCURRENCE NAME	COMMODITIES	GEOLOGICAL DESCRIPTION
1	Vein	094C 120	CR	Cu	Epidote alteration and malachite staining are found in massive maroon basalt flows of the Takla Group.
2	Vein	094C 121	Nuthatch	Cu	Epidote alteration and malachite staining are found in massive maroon basalt flows of the Takla Group. May have carbonate veining and flows are locally sheared and fractured. Minor azurite present. Mineralized zone is at least 15 m across.
3	unknown	094C 042	Mercury 2	Hg	Carbonatized fault zone contains some cinnabar, apparently in Lay Range sediments.
4	Vein?	094C 015	Stranger	Au	Pyrite occurs in quartz-calcite veins which cut Big Creek group calcareous black slatey argillite.
5	unknown	094C 041	Mercury 1	Hg	Carbonatized fault zone contains a little cinnabar (in upper Lay Range sediments).
6	Porphyry and vein	new	Zip	Cu	Takla Group tuffs are strongly fractured and pervasively cut by quartz-carbonate veins. Minor malachite staining seen in some places.
7	Vein	new	Ran	Cu	Takla Group volcanics and sediments are cut by a quartz vein 10-20 cm thick. Rusty fractures are coated with malachite and chalcopyrite.
8	Vein	094C 135	Mat 3	Ag, Pb, Zn, Cu	Quartz vein hosting galena, sphalerite, chalcopyrite, pyrite and silver sulpho-salts. A reported sample assayed 763g/t Ag. Similar to the MAT 1 occurrence (MINFILE NO. 094C 099). Hostrocks are volcanics and sediments of the Takla Group.
9	Porphyry and vein	new	Choice	Cu	Minor disseminated chalcopyrite with malachite haloes and malachite on fracture surfaces of Takla Group volcanic tuffs and augite porphyry (flows?). Locally highly silica, carbonate and epidote altered.
10	Vein	094C 137	Tut 3	Au, Ag, Cu, Mo	Takla Group volcanics host a vuggy limonite-stained quartz vein with disseminated malachite and molybdenum.
11	Unknown	new	Ache	Cu	Blebs of chalcopyrite and trace malachite occur on fracture surfaces and with epidote and calcite veining in augite porphyry agglomerate flows of the Takla Group.
12	Shear and porphyry(?)	094C 136	Tut 6	Cu, Au, Ag	Hosted in volcanics and tuffs of the Takla Group which are cut by sheared and silicified monzonite and syenite dikes with chalcopyrite and pyrite mineralization. One reported sample assayed 0.89% Cu, 0.15g/t Au, 10.0g/t Ag.
13	Vein	094C 055	Tutizzi Lead	Pb, Cu	Reported occurrence of quartz veins north of Tutizzi Lake containing galena, commonly with chalcopyrite or specularite, hosted in Takla Group volcanics and sediments.
14	Vein	094C 052	Tutizzi Copper	Cu,Pb	Reported occurrence of galena, chalcopyrite and/or specularite in quartz veins within the mafic-ultramafic unit (possibly related to the Hogem intrusive complex) near the contact with volcanics and sediments of the Takla Group.
15	Vein	094C 053	Tutizzi Lake	Pb,Cu,Ag	Mafic intrusives possibly related to the Hogem intrusive complex host a 90 cm wide brecciated quartz pod mineralized with galena and chalcopyrite. Reported assays have returned values up to 0.26 g/t Au, 176.2 g/t Ag, 1.44% Cu and 50.38 % Pb.
16	Unknown	094C 056	Izzi	Au, Cu	A gossan zone within hornblende-bearing pyroxenite, possibly related to the Hogem intrusive complex, contains chalcopyrite, malachite, hematite and pyrite. Reported chip samples assayed as high as 1.525g/t Au.
17	Unknown	new	Ant	Cu	A pyritic zone in a pyroxenite body, possibly related to the Hogem intrusive complex, hosts malachite staining; also a nearby gabbroic phase shows trace malachite.
18	Unknown	new	Welt	Cu	Malachite occurs at the contact between Takla Group volcanics and monzodiorite possibly related to the Hogem intrusive complex.
19	Porphyry	094C 064	Grouse North	Mo	Fine to medium-grained pink syenite hosts molybdenite in two well developed fracture sets.
20	Vein	094C 078	Grouse	Mo	A 40 cm wide quartz vein within the Hogem intrusive complex contains minor molybdenite.
21	Vein	094C 054	Abraham Creek	Pb, Cu	Reported occurrence of quartz veins west of Abraham Creek containing galena, commonly with chalcopyrite or specularite, hosted in hornblende diorite and appanite of the Hogem intrusive complex.
22	Vein	new	Misty	Cu	Hydrothermally altered volcanics and sediments of the Takla Group are cut by a carbonate vein mineralized with malachite and azurite.
23	Porphyry?	new	Bell	Cu	Takla Group volcanics and sediments are intruded by medium to coarse-grained gabbro in which a small area has malachite disseminated throughout and very minor chalcopyrite.
24	Porphyry and vein	new	Shot	Cu	Fine to medium-grained gabbro contains rusty zone with malachite and azurite staining with possible chalcopyrite in a small 1m square area. Quartz veining and silica alteration are present.
25	Shear and/or vein	new	Anorak	Cu	Malachite on fracture surfaces at the foliated/sheared contact between Takla Group volcanics and a diorite body. The diorite can be siliceously altered with 1-5% pyrite.
26	Porphyry and vein	094C 040	Mes(Link)	Cu, Mo	The showing is hosted by Takla Group rocks near the contact with the Hogem intrusive complex. Phyllic and argillic alteration are common with local silicification and pyritization (up to 20% of volume). Within the gossan zone, pyrite averages 1-3%. Malachite, molybdenite, azurite and tenorite have been identified in the area of the showing.

27	Porphyry	094C 007	Porphyry Creek	Cu, Au, Pb, Mo, Zn	Widely altered (chlorite, epidote, biotite, silica) volcanics and sediments of the Takla Group are intruded by primarily mafic phases probably related to the Hogem intrusive complex. Widespread copper mineralization comprising chalcopyrite, with or without malachite, azurite, and rare chalcocite or bornite occurs as disseminations, fracture fillings and in shears. Specks of native gold have been found in pan concentrates and in quartz-carbonate veins. Galena +/- sphalerite occurs locally in quartz-carbonate veins. Molybdenum is also found in quartz-carbonate +/- potassium feldspar veins.
28	Shear and vein	094C 008	Croydon	Au, Cu, Mo	Hostrocks are altered hornblende diorite and amphibolite, possibly part of the Hogem intrusive complex. Mineralization occurs in four fracture zones partially filled with vein quartz, with pyrite and chalcopyrite being the main metallic minerals. Lesser magnetite molybdenite and gold are also present, in local areas of almost massive sulphide.
29	Unknown	094C 065	Porphyry Creek Molybdenum	Mo	Reported molybdenum showing in mafic rocks related to the Hogem intrusive complex.
30	Unknown	094C 066	Croydon North	Au	Two reported assays showed 10.29 and 4.11g/t Au. Mineralization is hosted in mafic and ultramafic rocks possibly related to the Hogem intrusive complex.
31	Porphyry?	new	Lonely	Cu	Takla Group volcanics and sediments are intruded by diorite and gabbro, likely part of the Hogem intrusive complex. Malachite and pyrite are found disseminated throughout and along fracture surfaces.
32	Disseminated and/or porphyry	new	Jump	Cu	Minor occurrences of malachite and possibly chalcopyrite hosted in Takla Group volcanics and flows. Appears to be some association with mafic-rich marginal phase of hornblende porphyry dike which cuts flows of augite/feldspar porphyry agglomerate. There is some local shearing but its relationship to the mineralizing event is unclear.
33	Vein	094C 128	South Sarah	Cu, Au, Ag, Hg	Takla Group volcanic rocks are propylitically altered and minor showings of chalcopyrite are common. A reported grab sample from quartz-carbonate veins contains 6.06% Cu, 78.4 g/t Ag, 1.6 g/t Hg and 13.5 g/t Au.
34	Skarn	094C 084	Bloom Cirque Skarns	Cu, Fe	Sparse and erratic chalcopyrite with malachite and azurite occur in four occurrences of magnetite skarn... along the margins of Bloom cirque. Host rocks are calcsilicate horizons within Takla Group rocks. Diorite phases of the Hogem intrusive complex outcrop 100 m west of the occurrence.
35	Porphyry and vein	094C 009	Granite Basin	Au, Ag, Cu	Takla Group rocks are intruded by phases of the Hogem intrusive complex. Pyrite, chalcopyrite and possibly bornite and tetrahedrite are present in four pyritic zones. Assays reportedly reach up to 11.4 g/t Au over 9 m.
36	Porphyry and vein	094C 039	Bloom Cirque	Co, Cu	Minor cobalt bloom on fracture surfaces in small quartz veins and minor occurrences of fracture-controlled and disseminated chalcopyrite, malachite and pyrite are present throughout fine-grained hornblende diorite and quartz diorite. Widespread weak to strong propylitic alteration accompanies the mineralization.
37	Vein and porphyry	094C 075	Sarah	Cu, Au, Ag	The occurrence consists of fracture coatings and disseminations of pyrite, chalcopyrite and malachite with minor bornite in mafic intrusives of the Hogem intrusive complex. One 30 cm wide vein assayed 5.28% Cu, 7.5 g/t Au and 55.5 g/t Ag. Epidote and chlorite alteration are present.
38	Unknown	new	Rave	Cu	An extensive gossan zone in the Takla Group volcanics and sediments carries small amounts of malachite and chalcopyrite.
39	Porphyry	094C 127	Raven	Cu, Pb, Zn	Chalcopyrite is found in monzonite porphyry dikes with magnetite, pyrrhotite and pyrite as fracture-controlled blebs and pods in Takla Group tuffs. Also present are minor galena and sphalerite.
40	Porphyry and vein	new	Howl	Cu	Takla Group volcanics and sediments are cut by small (2-10 cm) quartz-carbonate veins. Malachite and chalcopyrite are found in the veins and minor malachite on fracture surfaces in the area. Some mineralization appears to be associated with small ultramafic dikes which cut the Takla Group.
41	Shear and vein	094C 122	LCF	Au, Ag	Altered and quartz-carbonate veined Takla Group rocks yielded a geochemical analysis of 6.68 g/t Au and 4.4 g/t Ag.
42	Shear	new	Webb	Cu	Malachite staining occurs on fracture surfaces in an ankerite-altered fault zone within a massive serpentinite body in the Lay Range assemblage.
43	Shear	new	Hoot	Cu	The upper unit of the Lay Range assemblage sediments are strongly sheared and locally silicified. A small amount of malachite staining occurs on fracture surfaces associated with the shearing.
44	Shear and vein	094C 012	Jupiter	Au, Ag, Cu, Pb, Zn	A quartz-carbonate-cemented fault breccia zone hosts Au, Ag, Cu, and Zn mineralization. Another area of quartz and calcite fissure veins is heavily mineralized with sphalerite, tetrahedrite, galena, and minor chalcopyrite, covellite, and pyrrhotite. The main showing has been explored with a 242 m adit with several crosscuts.
45	Porphyry and vein	094C 091	Polaris Cu-Mo	Cu, Mo	Small quartz monzonite bodies intrude pyritized volcanics of the problematic unit. Chalcopyrite and minor molybdenite are hosted in fractures within both lithologies. A reported grab sample assayed 0.234% Cu and 0.004% Mo.
46	Shear and vein	094C 013	Polaris	Au, Ag, Cu, Mo	Small quartz and quartz-calcite veins containing disseminated, banded or blebby pyrite, arsenopyrite and pyrrhotite are hosted by calcareous and cherty black argillite. Assays of more than 100 g/t Au are reported. Also reported are lenses of massive sulphide up to 9 m thick and 30 m long consisting of pyrrhotite with minor pyrite and chalcopyrite. A third zone contains chalcopyrite and molybdenite in fractures in quartz monzonite and pyritized volcanic rock
47	Unknown	094C 059	Polaris zinc	Zn, Cu	Volcanics tuffs and sediments of the Takla Group are sheared by the Lay Creek fault and reportedly host zinc and copper mineralization. No further information is available on the occurrence.
48	Ultramafic hosted	094C 090	Aiken Lake	Cr, asbestos	The Polaris Ultramafic Complex carries flexible, asbestiform chrysotile and a few minor occurrences of disseminated to banded chromite within serpentinized peridotite, dunite and pyroxenite intrusions.

49	Unknown	094C 081	Mes	Cu	Pyrite and minor chalcopyrite occur in fractures in the problematic unit volcanics near quartz monzonite intrusions.
50	Carbonate-hosted base and precious metals	094C 074	Rain	Pb, Zn, Ag, Ba	Tan dolomitic zones occur in a grey limestone and Pb-Zn-Ba mineralization occurs in a white crystalline phase of dolomite. Two showings 750 m apart assayed 0.82 % Pb, 3.68 % Zn, 3.4 g/t Ag and 14.5 % Ba and, 4.53 % Pb, 4.2 % Zn, 3.12 g/t Ag and 31.0% Ba respectively. Host lithology is uncertain, but believed to be either Echo Lake group or Mount Kison formation limestone.
51	Vein and shear	new	Ritz	Cu	Interbedded thinly layered brown limestone and phyllite of the Tsaydiz Formation of the Ingenika Group are cut by quartz veins, up to 50 cm thick, which contain carbonate and sulphides with malachite staining.
52	Shear and vein	094C 079	Nel	Ag, Cu, Zn, Pb, Au	Galena, tetrahedrite, pyrargyrite, argentite, chalcopyrite and pyrite have been identified in quartz veins and breccias. Silicification, sericite-pyrite alteration and mineralized strongly leached gouge material are also described at the occurrence which is hosted by quartzites, grits and schists of the Swannell Formation of the Ingenika Group.
53	Carbonate-hosted base and precious metals (replacement)	new	Knoll	Pb, Zn, Ba	Sphalerite, galena and barite mineralization occurs in a rusty sparry dolomite section of the dolomite and siliceous dolomite breccias of the Echo Lake group.
54	Carbonate-hosted base and precious metals (replacement)	094C 082	Crag	Pb, Zn, Ag, Ba	Fine-grained galena with minor sphalerite and pyrite occurs in a 1m wide dolomitic zone which crosscuts massive white limestone of the Mount Kison formation. A grab sample reportedly assayed 5.0% Pb, 2.8% Zn, 188.6 g/t Ag and 0.48% Ba.
55	Carbonate-hosted base and precious metals (replacement)	new	Sing	Pb,Ba	Coarsely recrystallized limestone in the Echo Lake group hosts coarsely crystalline barite and finely disseminated galena.
56	Carbonate-hosted base and precious metals (replacement)	094C 073	Swan	Pb, Zn, Ag	Scattered lenses of galena and light brown sphalerite are hosted by a tan-weathered cream-coloured band near the top of the massive white limestone unit. The highest reported assay is 0.48% Pb, 1.72% Zn, and 4.11 g/t Ag across 1.5 m.
57	Carbonate-hosted base and precious metals (replacement)	094C 096	Whistler	Zn, Pb	Galena, sphalerite, pyrite and barite occur in coarsely crystalline dolomite within the Otter Lakes group. Two showings occur along a stream cut just below the contact with Big Creek group sediments.
58	Carbonate-hosted base and precious metals (replacement)	094C 033	Gordon	Zn, Pb	Primary and secondary breccias of the Echo Lake group host sphalerite, galena and pyrite as replacements of the dolomite or as disseminations. Barite is also present. A reported chip sample across 2 m assayed 2.6% Pb.
59	Carbonate-hosted base and precious metals (replacement)	new	Upper Osprey	Cu, Zn, Pb?	Primary and secondary breccias of the Echo Lake group have been strongly mineralized by veining and replacement. A large gossanous zone at least 10 m by 20 m contains several zones of massive sulphide each exposed over 10 m by 5 m and greater. Sulphides include pyrite, chalcopyrite, sphalerite, +/- galena and bornite. A second occurrence less than 100 m away, is strongly mineralized with pyrite +/- chalcopyrite and malachite. This appears to be a quartz latite intrusion, pipe-like in shape and about 8 m across.
60	Carbonate-hosted base and precious metals (replacement)	new	Thrust	Cu, Zn	Patchy sphalerite and blebs of chalcopyrite occur in recrystallized dolostone in the middle of the brecciated zone of the End Lake thrust. The thrust places Razorback group on top of dolomite breccias of the Echo Lake group.
61	Carbonate-hosted base and precious metals (replacement)	094C 129	Osprey	Pb,Zn	An 80 m long gossanous outcrop of primary and secondary breccias of the Echo Lake group hosts pervasive sphalerite with higher grade sections found in apparent shear zones. A 2 m chip sample reported 15.8% Zn and 0.34%Pb.
62	Carbonate-hosted base and precious metals (replacement)	094C 031	Molly	Zn, Ag, Pb, Ba	Sphalerite and barite with minor galena, quartz, calcite and pyrite occur as disseminations and in irregular patches replacing the limestone. Locally mineralization appears conformable to bedding. A 4 m chip sample from a trench reportedly assayed 6% Zn, 0.015% Pb and 20 g/t Ag.
63	Carbonate-hosted base and precious metals (replacement)	094C 032	Gwynn	Pb, Ba	Galena with barite and minor quartz are exposed in trenches within the Echo Lake group dolostones.
64	Carbonate-hosted base and precious metals (replacement)	094C 030	Elizabeth	Pb, Zn	Echo Lake group dolostones host sphalerite with minor galena and barite. A reported 15 m trench sample assayed 2% Zn.
65	Carbonate-hosted base and precious metals (replacement)	094C 029	Childhood Dream	Ag, Au, Zn, Pb	Primary and secondary breccias of the Echo Lake group host massive to coarse-grained pyrite with disseminated galena and sphalerite as replacement and breccia infillings. There are two exploration adits, one 5 m and one 10 m long. The best chip sample reportedly assayed 0.34 g/t Au, 24.0 g/t Ag, 2.6% Pb and 11.2% Zn.
66	Carbonate-hosted base and precious metals (replacement)	094C 080	Greg	Zn, Pb	Disseminated sphalerite and galena reportedly occur within blackish limestone, which is mapped as Echo Lake group but may be Otter Lakes group rocks.
67	Carbonate-hosted base and precious metals (replacement)	094C 130	Carie	Pb, Zn, Ag, Ba	The showing is hosted within a dolomitized carbonate breccia (probably primary) of the Echo Lake group, near a fault contact with Big Creek sediments. Disseminated and massive galena, disseminated sphalerite, hydrozincite and smithsonite and locally massive crystalline barite are present.
68	Carbonate-hosted base and precious metals (replacement and stratabound)	094C 024	Par / Weber	Zn, Pb, Au, Ag	The area of the prospect is underlain by the Lower Cambrian Mount Kison formation and the Ordovician to Middle Devonian Razorback, Echo Lake and Otter Lakes groups. Mineralization in variable amounts is found in each of the above mentioned strata. By far the most interesting and prospective mineralization found to date consists of thin lenses of 60-80% sulphide rock intercalated with shales, phyllites and dolomite boudins of the Razorback group.
69	Stratabound carbonate-hosted base metals	094C 103	Critter	Zn, Ba?	Disseminated sphalerite with possible barite found in recrystallized and brecciated sections of light to dark grey dolomite of the Otter Lakes group.

70	Carbonate-hosted base and precious metals and vein/ replacement	094C 023	Beveley	Pb, Zn, Ag, Ba	Disseminated to massive galena, sphalerite, barite and argentiferous galena occur as veins and veinlets, in fractures and shears within the Mount Kison formation of the Atan Group, the Echo Lake group and possibly the Otter Lakes group in several zones on the Beveley prospect. Mineralization appears to be localized in minor folds, flexures and warps on larger scale folds in the area.
71	Veins	094C 104	Quarry	Pb, Zn, Cu, Au, Sb	Recrystallized and dolomitized limestones of the Espee Formation host quartz vein mineralization. Minerals identified in hand samples include sphalerite, galena, cerussite, chalcopyrite, boulangerite, malachite, azurite and possibly stibnite. Fire assays on two grab samples from this location returned values of 890 ppb and 385 ppb Au.
72	Vein/ replacement?	094C 038	Regent	Pb, Ag	Massive, argentiferous, crystalline galena occurs in an irregular pod-shaped vein and is hosted in Espee Formation dolomite and limestone(assay: 1575 g/t Ag).
73	Shear-controlled quartz vein	094C 105	Gael	Ag, Au, Cu	Disseminated fine-grained argentite and arsenopyrite are hosted by a shear-controlled quartz vein within the Swannell Formation of the Ingenika Group.

The Polaris Ultramafic Complex is host to minor chromite and chrysotile asbestos mineralization. Chromite at the Aiken Lake showing consists of ball-like masses up to 5 centimetres across, as disseminated grains up to 3 millimetres in diameter and in layers up to 30 centimetres thick with up to 5 per cent chromite. Platinum group elements have been detected by stream sediment sampling around the Polaris Complex but have not been found in outcrop.

CONCLUSIONS

- Mapping in Cassiar rocks of the Aiken Lake area has delineated a sequence of Paleozoic siliciclastics and carbonates very similar to those in the Osilinka River area. Basinal and platformal facies may be present.
- A re-examination of the Lay Range assemblage in its type locality has led to recognition of a lower sedimentary division and an upper mafic tuff division. The dacitic tuff unit (MPlr4) and argillite unit (MPlr3) are now believed to be part of the North American Cassiar Terrane.
- Takla Group volcanics are dominated by tuffs at least 4000 metres or more thick. Coarse volcaniclastic units are subordinate. Abrupt lateral facies variations between the various lithologies are present within the map area.
- A package of rocks east of Lay Creek, originally mapped as Lay Range assemblage, is probably part of the Takla Group.
- Major strike-slip structures cut through the map area and are part of the Lay Range fault system. This fault zone joins fault zones mapped south of the area.
- Mineral occurrences in the map area are dominated by porphyry copper-gold prospects within the Takla Group and at the Hogem-Takla contact, and by carbonate hosted lead-zinc showings in carbonates of the Cassiar Terrane.

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