# Devono-Mississippian Felsic Volcanism Along the Western Edge of the Cassiar Terrane, North-Central British Columbia (NTS 93N, 94C and 94D)

By Filippo Ferri

## INTRODUCTION

The Late Devonian to Early Mississippian is an important metallogenic epoch within the Canadian cordillera resulting in the production of significant sediment exhalative massive sulphide (SEDEX) and volcanogenic massive sulphide (VMS) mineral occurrences within rocks of cratonic or pericratonic affinity. Major belts include the Late Devonian Earn-hosted SEDEX deposits of the Selwyn and Gataga districts (Tom, Jason, Driftpile Creek, Cirque) and the VMS occurrences within Eagle Bay rocks of the Barriere area (Homestake, Rea). The recent discoveries of the Kudz Ze Kayah, Wolverine, Fyre Lake and Wolf VMS deposits hosted by Devono-Mississippian pericratonic and cratonic rocks of the Yukon-Tanana and Cassiar terranes (Figure 1) again underlines the economic importance of this geologic time interval.

The British Columbia Geological Survey Branch initiated a mapping program focused on a sedimentary sequence with intercalated Devono-Mississippian felsic volcanics in the Johanson Lake area. Previous geologic mapping by the British Columbia Geological Survey Branch between Manson Creek and Aiken Lake delineated a belt of Devono-Mississippian felsic volcanics along the western margin of the Cassiar Terrane (Figure 2; Ferri and Melville, 1994; Ferri *et al*., 1992a, b; 1993a, b). These felsic volcanics, locally termed the Gilliland Tuff, can be traced intermittently for approximately 150 kilometres and can exceed 1000 metres in thickness. They are found within the Big Creek Group, part of the Earn Assemblage, a package which contains both SEDEX and VMS mineral targets. The presence of felsic volcanics within Big Creek rocks may indicate VMS potential.

The objectives of the mapping project were to: 1) evaluate the Omineca Queen bedded barite occurrence and determine its relationship to the felsic volcanism of the Gilliland Tuff; 2) trace these felsic volcanics northward; 3) determine the economic potential of the felsic volcanics and enclosing lithologies for hosting VMS and SEDEX deposits and 4) examine the Lay Range Assemblage, the lower part of which may be equivalent to the Yukon-Tanana Terrane.

This paper summarizes initial results from the mapping program and some key points of the property visit to

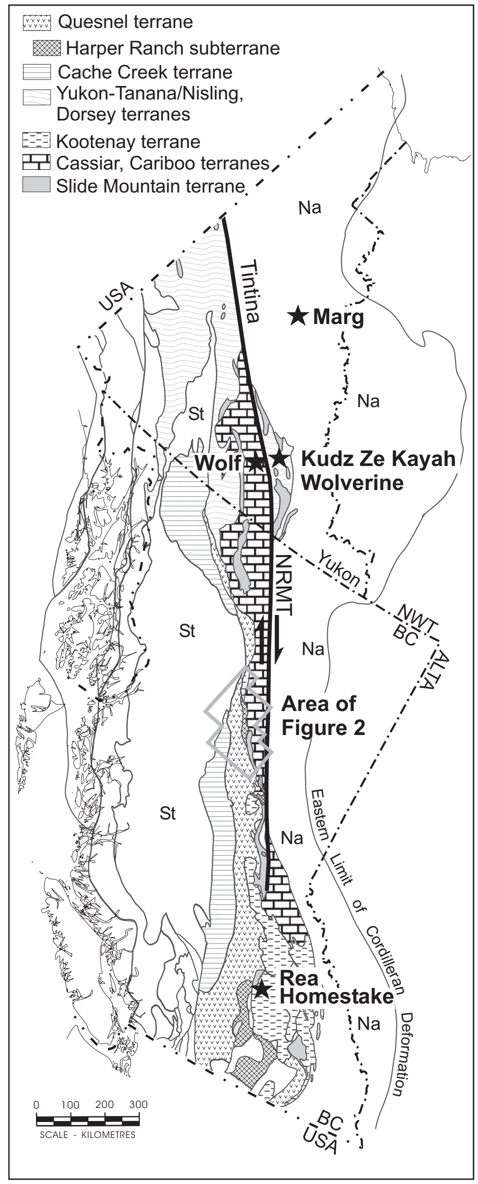



Figure 1. Simplified tectonic assemblage map of the Canadian Cordillera showing the location of the map area with respect to the main terrane assemblages near the contact between Ancestral North American rocks and those of suspect affinity. St: Stikine Terrane, Na: Ancestral North America; NRMT: Northern Rocky Mountain Trench.

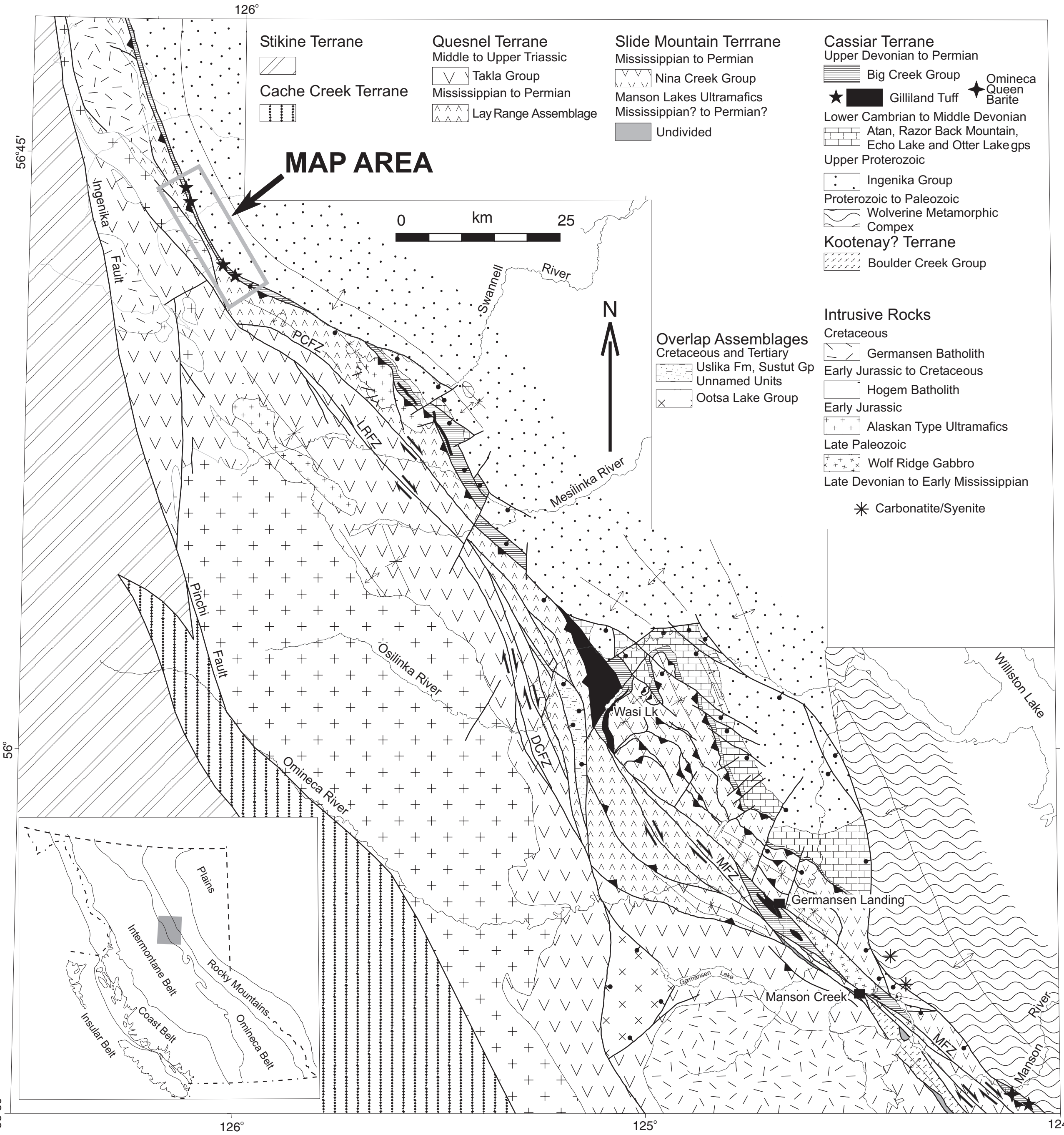



Figure 2. General geology map of the region south of and adjoining the present map area. The bulk of the geology shown is taken from work during the Manson Creek (Ferri and Melville, 1994) and Aiken Lake (Ferri *et al*. 1992a, b and 1993a, b) projects. The area east of the Germansen Batholith is taken from Nelson and Bellefontaine (1996). PCFZ: Polaris Creek Fault Zone. LRFZ: Lay Range Fault Zone. DCFZ: Discovery Creek Fault Zone. MFZ: Manson Fault Zone.

the Omineca Queen barite occurrence. The geology of this property will be reported in greater detail in a later publication.

The map area forms a narrow, northwest-trending belt measuring 5 by 25 kilometres extending from the headwaters of the Swannell River to the Fleet Peak area (Figure 3). The centre of the map area is approximately 15 kilometres northeast of Johanson Lake which is roughly 400 kilometres by road to the towns of Fort St. James or Mackenzie. The area is accessible by helicopter and by foot or pack horse from the Omineca Mining Access Road.

Mapping commenced along the western edge of the Mesilinka River sheet (NTS 94C) and extended northwestward into the McConnell map area (NTS 94D). The southern part of the map area overlaps with a portion

## MIDDLE JURASSIC

**Jq** *Buff-white weathering, white to pale grey, medium grained, equigranular hornblende-bearing quartz monzonite/monzonite/quartz diorite/diorite*

## LATE TRIASSIC

### Wrede Complex

**Twhd** *Pale grey to black weathering, fine to coarse grained hornblende diorite or gabbro/clinopyroxene-hornblende diorite or gabbro plagioclase*

**Twh** *Medium brown weathering, coarse grained hornblende clinopyroxenite*

**Twc** *Dark to medium grey-green weathering, medium to coarse grained undifferentiated clinopyroxenite, includes hornblende clinopyroxenite, olivine clinopryoxenite and olivine-hornblened clinopyroxenite*

**Two** *Medium to pale grey-green weathering, medium to coarse grained olivine clinopyroxenite*

**Tww** *Dark to medium brown weathering, predominantly medium grained or medium to coarse grained wehrlite*

**Twd** *Pale buff-orange weathering, dark grey to black, fine to medium grained dunite*

**Tgh** *Rusty weathering, grey-green, biotite-bearing gabbro and grey to orange weathering coarsely crystalline hornblendite*

### Takla Group

**Tt** *Pale to medium grey-green weathering, dark grey-green augite-feldspar bearing volcanic breccia, tuffs and flows*

## MIDDLE PENNSYLVANIAN? TO PERMIAN

### Lay Range Assemblage

#### Upper Mafic Tuff Division

**PIrua** *Grey-geen or maroon weathering, pale to dark green and maroon, feldspar-pyroxene lapilli tuffs volcanic breccia, flows and lesser crystal tuffs. Rare grey limestone*

**PIru** *Pale greenish grey to green weathering, green to grey green thin to thickly bedded and well laminated tuff. Locally dark green aphanitic basalt with associated lapilli tuff and volcanic breccia.✦ Rare rusty weathering, quartz-bearing tuff to sericite schist*

**MPIrll** *Grey to buff weathering grey limestone. Massive to platy, locally bioclastic with interlayers of beige to pale grey chert. Locally contains maroon and green siltstone or tuffaceous horizons. Tan to buff weathering, white to cream recrystallized massive dolomite*

**MPIrlv** *Grey-brown weathering, dark green, aphanitic basalt, lesser volcanic breccia and tuff. Locally spheriolitic. Pale to green, medium to coarsely crysalline gabbro to quartz monzonite, locally foliated*

**MPIrl** *Thick to massively bedded, beige to brown weathering, tan to greenish brown calcareous sandstone, very fine to granule conglomerate. Interlayered with black argillite, green tuffaceous siltstone, thin bedded whiite to grey chert and brown to orange weathering grey platy limestone*

The region west of 126°W occurs within UTM Zone 9.
The region east of 126°W occurs within UTM Zone 10.
This map is NAD83 Universal Transverse Mercator.

## LATE DEVONIAN TO PERMIAN

### Big Creek Group

**DPbc** *Dark grey, dark blue-grey to black slate and thin to moderately bedded argillite. Minor horizons of dark grey to black quartz-chertz wackes, sandstones and lesser granule conglomerate.★ Locally contains thin horizons of light coloured quartz-feldspar-bearing felsic tuff and dark green basalt.*

**DMgt** *'Gilliland Tuff': Rusty to tan weathering, pale grey to dark grey or greenish grey, quartz-feldspar tuff to lapilli tuff. Sericitic and locally contains pryrite and ankerite porphyroblasts. Minor argillite clasts. Locally contains tan to grey weathering, very fine to medium crystalline diorite or quartz diorite which can be associated with dark green basalt.*

## LATE PROTEROZOIC

### Ingenika Group

#### Stelkuz Formation

**Pst** *Rusty brown weathering, greenish grey slate, lesser thin to massively bedded cream impure quartzite and quartz sandstone and thinly bedded, grey limestone*

#### Espee Formation

**Pes** Grey to buff weathering, platy and blocky, finely recrystallized limestone and dolomitic limestone, grey calcareous slate. Cross-cutting zones of orange weathering, coarsely crystalline dolostone are locally present.

#### Tsaydiz Formation

**Pts** *Thinly interlayered, grey to orange-brown weathering, grey to green-grey slate, calcareous slate and grey to orange weathering, grey limestone.*

#### Swannell Formation

**Psw** *Thickly bedded, grey-green to green, feldspar-bearing quartz sandstone to wacke, quartz sandstone, slate, siltstone, impure quartzite and rare grey limestone. Schistose in its lowest parts, locally containing biotite porphyroblasts.*

Geologic boundary (approximate, assumed):

Thrust Fault (approximate, assumed):

Fault, unknown displacement (approximate, assumed):

Fold axis, overturned (anticline, syncline):

Bedding (tops known-inclined, vertical overturned-inclined vertical, unknown-inclined vertical): ...................................... 84 30 66

Foliation (first, second generations inclned, vertical): ...................................... 67 54

Chromite schlieren (inclined vertical) ...... 31

Bedding cleavage intersection: ................. 50

Fold axis: .................................................. 18

Fold axial plane: ....................................... 80

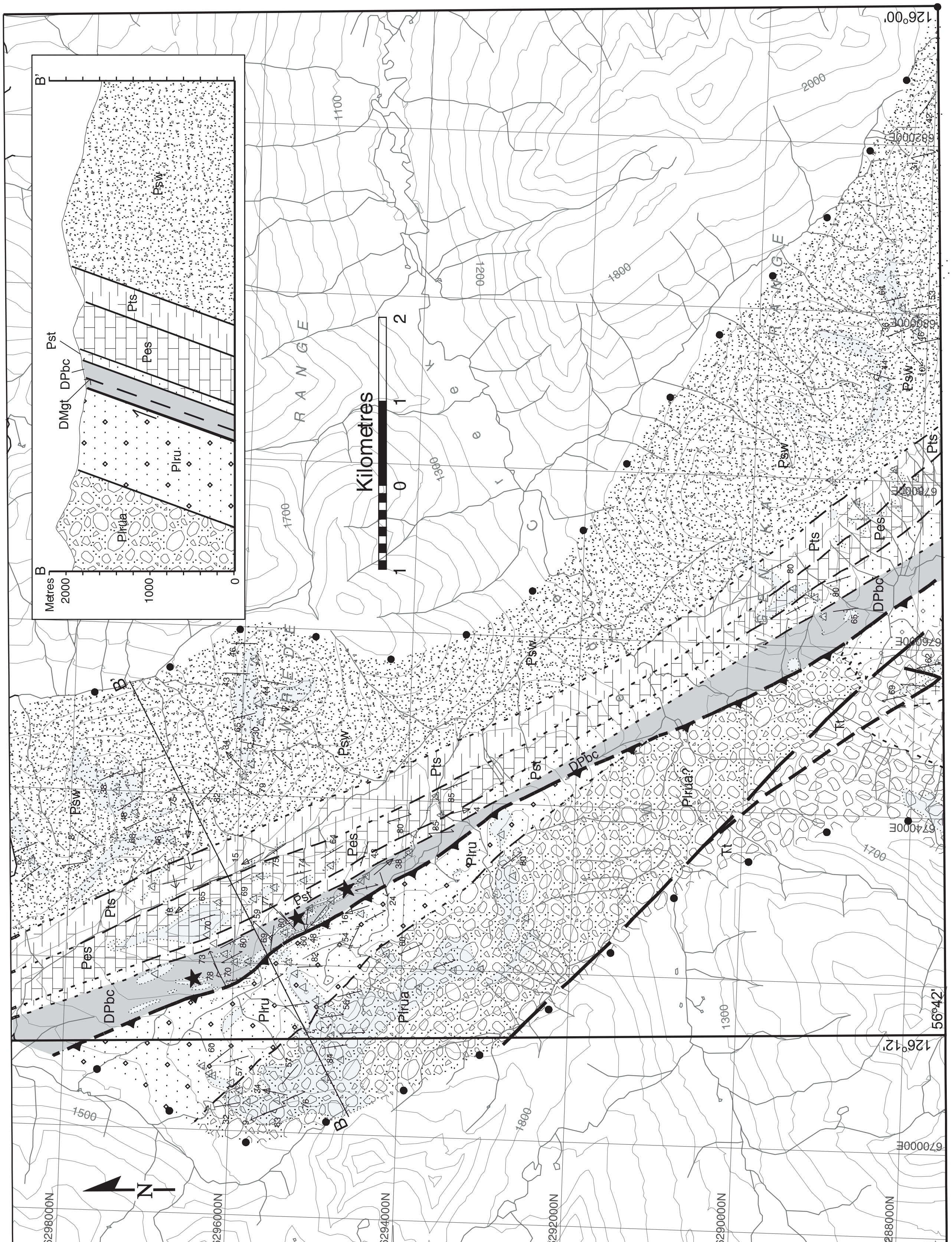
Shear zone: ..............................................

Field station: .............................................

Area of abundant exposure: .....................

Geology of the Wrede Complex taken from Nixon et al. (1998).

Figure 3. Geological map of the project area. (a) Southern portion. (b) Northern part. (c) Geological legend to accompany Figures 3(a) and (b). Geology of the Wrede Complex taken from Nixon *et al.* (1998).


Metres
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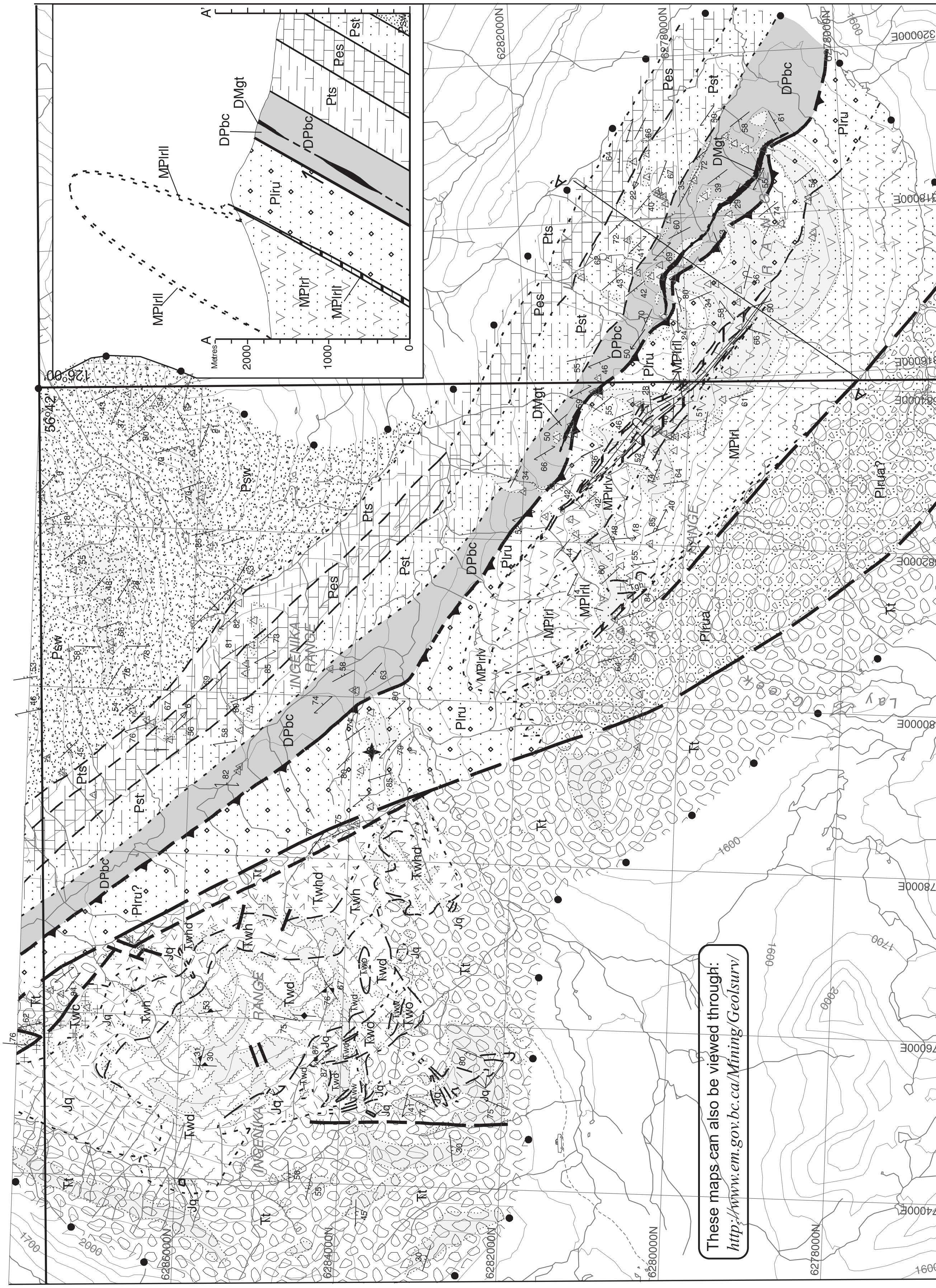
These maps can also be viewed through:
http://www.em.gov.bc.ca/Mining/Geolsurv/
INGENIKA RANGE
DPbc
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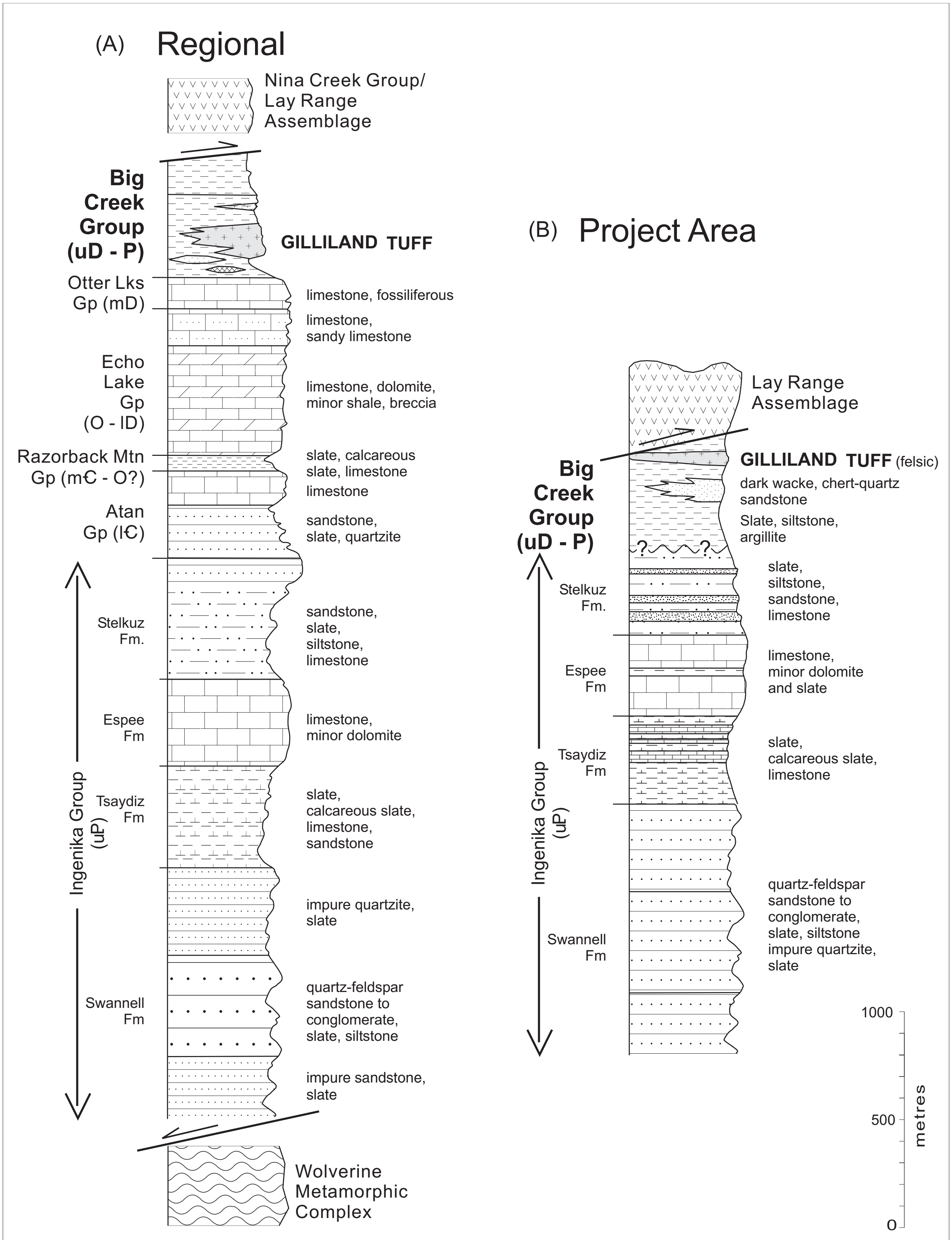


Figure 4. Simplified stratigraphic columns of Ancestral North American stratigraphy. (A) Regional stratigraphy of the Cassiar Terrane between the Omineca and Swannell rivers. (B) Stratigraphic units found in the present map area.

of Open File Map 1993-2 (Ferri *et al*., 1993a, b). The geology in this section of the open file was originally reproduced from unpublished maps and field notes provided by J.W.H. Monger from the Geological Survey of Canada. Some of this information was also incorporated into the present mapping. The opportunity to use this information is gratefully appreciated.

## REGIONAL SETTING

The map area straddles the boundary between displaced Ancestral North American rocks of the Cassiar Terrane to the east and volcanic arc and peri-cratonic? rocks of the Quesnel Terrane to the west. In the map area, the Cassiar Terrane is represented by the Ingenika and the Big Creek groups (Figures 2 and 3). The Late Proterozoic Ingenika Group represents a rift to shallow shelf sequence and is subdivided into, from oldest to youngest, rift clastics of the Swannell Formation, upwards shoaling slates and carbonates of the Tsaydiz Formation, shallow carbonates of the Espee Formation and rift-related? clastics and carbonates of the Stelkuz Formation (Mansy and Gabrielse, 1978). Regionally, these rocks are overlain by a carbonate-rich, shallow shelf sequence of Early Cambrian to Middle Devonian in age (Figure 4). These rocks are missing in the map area and the Big Creek Group sits directly atop the Ingenika Group.

The Middle Devonian to Permian Big Creek Group is a dominantly argillaceous sequence. This unit belongs to the Earn Assemblage, a deeper water shale succession. The Earn Assemblage formed, in part, due to the foundering of the ancient carbonate platform which is believed to have occurred in response to rifting in the northern Canadian Cordillera (Gordey *et al*., 1987). The upper part of the Big Creek Group contains a Late Devonian to Early Mississippian calc-alkaline felsic tuff or quartz-feldspar porphyry, locally termed the Gilliland Tuff (Ferri and Melville, 1994).

The Lay Range Assemblage sits structurally above the Big Creek Group, the contact being an easterly directed thrust fault (Ferri *et al*., 1993b; Nixon *et al*., 1993). The Lay Range Assemblage represents a middle to late Paleozoic arc-succession which forms basement to the Late Triassic to Early Jurassic Takla Group volcanics (Ferri, 1997). These rocks have been intruded by the Late Triassic Wrede Creek Alaskan-type ultramafic complex (Nixon *et al*., 1998). To the south, late Paleozoic oceanic volcanics and sediments of the Nina Creek Group, belonging to the Slide Mountain Terrane, sit structurally above rocks of the Big Creek Group (Ferri and Melville, 1994).

Rocks of the Lay Range Assemblage, Takla Group and Wrede Complex, found along the southwest margin of the map area, form rugged alpine areas in excess of 2000 metres. The terrane along the northeastern part of the map area, underlain by rocks of the Swannell Formation, consists of rounded, glaciated peaks approaching 2000 metres in elevation. Recessive rocks of the Big Creek Group, together with those in the upper part of the Ingenika Group, form the subdued region between these two areas. Carbonate of the Espee Formation forms prominent ribs within this subdued area.

## STRATIGRAPHY

### Ingenika Group

The Late Proterozoic Ingenika Group is a dominantly clastic sequence and is subdivided into four formations which are, from oldest to youngest; the Swannell, Tsaydiz, Espee and Stelkuz formations. Regionally, rocks of the Atan Group sit conformably atop those of the Stelkuz Formation (Mansy and Gabrielse, 1978; Figure 4) and, based on trace fossil evidence, the Cambrian - Precambrian contact is believed to occur in the upper part of the Stelkuz Formation (Gabrielse and Campbell, 1991).

#### *Swannell Formation*

The Swannell Formation was examined along ridge tops located north and south of Wrede Creek (Ingenika and Wrede ranges), on the west flank of a broad $F_2$ or $F_3$ antiform. These resistive rocks form prominent exposures, particularly on north facing slopes (Photo 1). The Swannell Formation comprises a monotonous package of fine to coarse clastics, probably in excess of 2 kilometres in stratigraphic thickness, although a true measure is difficult to determine due to tectonic thickening.

The Swannell Formation is characterized by thickly bedded, grey-green to green, feldspar-bearing quartz sandstones to wackes, quartz sandstones, slate, siltstone, impure quartzite and rare limestone. These sandstones commonly display graded bedding and are typically coarse grained and locally granule conglomerates. Grains are typically angular resulting in these lithologies being referred to as ‘grits’ (Mansy and Gabrielse, 1978). Invariably, the sandstones contain a micaceous matrix which varies from 5 to 40 per cent of the rock. Quartz sandstones and quartzites are less common. Feldspar, either plagioclase or microcline, form conspicuous, chalky weathering grains making up to 15 per cent of the sandstone units. Tourmaline is a minor, but prominent accessory mineral. The upper part of the Swannell Formation is dominated by sandstone sections with lesser sequences of interbedded slate. Sections of predominantly grey-green to green slate/schist, with lesser sandstone, up to several hundred metres thick are common lower in the section. Slate is commonly interbedded with sandstone and can contain variable amounts of quartz and feldspar grains. Slates are locally crenulated lower in the stratigraphic section and can contain porphyroblasts of biotite.

#### *Tsaydiz Formation*

The Tsaydiz Formation typically forms a poorly exposed, recessive sequence above the Swannell Formation. It is conformable with the underlying Swannell Formation and comprises slate, calcareous slate, limestone and minor sandstone from 175 to 500 metres thick. South

Photo 1. Looking southeast at typical exposure of Swannell Formation within the Wrede Range. This photo shows the monotonous nature of this formation and the prominent ribs formed by the resistive sandstone sequences.

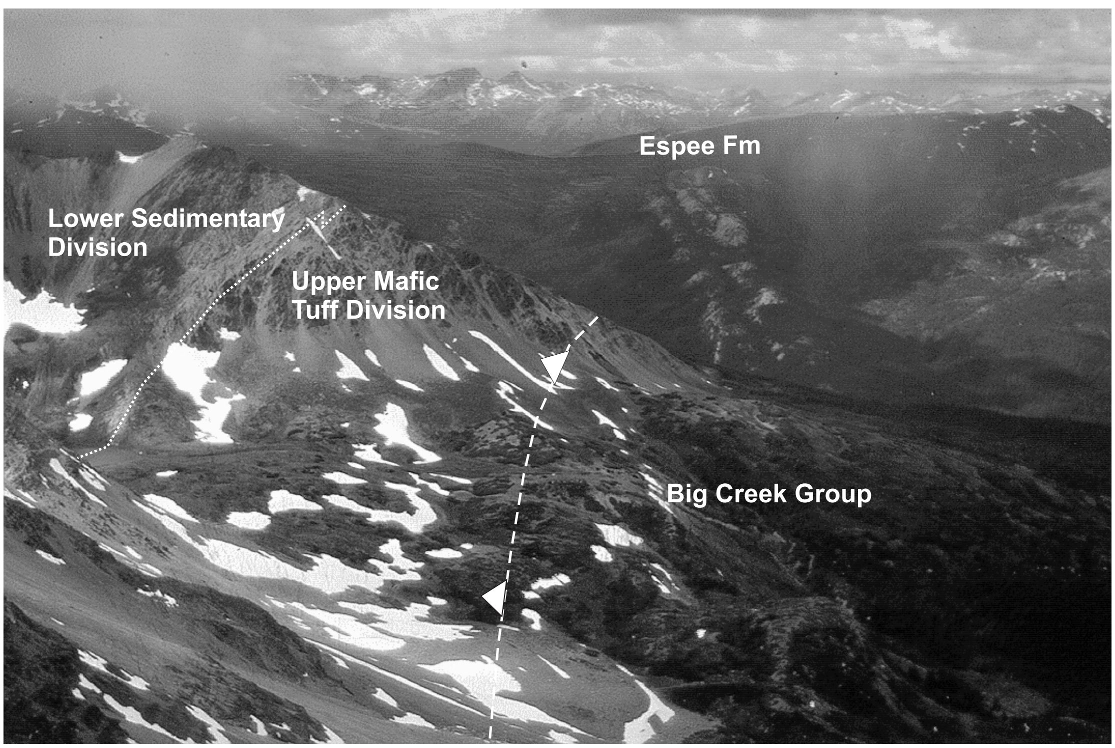


Photo 2. Looking northwest from the northern Lay Range towards the Ingenika Range. The thrust contact between the Lay Range Assemblage and Big Creek Group is shown in the foreground. Rocks of the Lay Range Assemblage are on the overturned eastern limb of an early northeast-verging anticline. The trace of this thrust is shown in the middle ground together with units of the underlying Ingenika Group.

of Wrede Creek, it is characterized by thinly interlayered, grey to orange-brown weathering, grey to green-grey slate, calcareous slate and grey to orange weathering, grey limestone. The amount of limestone diminishes down section resulting in thick sequences of grey, lustrous slate.

To the north, across Wrede Creek, the Tsaydiz Formation contains beds of limestone up to 20 centimetres thick near the Espee contact. In its lower parts, dark grey weathering limestone is from 2 to 5 metres in thickness, comprises up to 30 per cent of the section and locally contains up to 20 per cent dispersed, spherical quartz grains. This limestone is interlayered with typical Swannell sandstone at the base of the formation.

### *Espee Formation*

Limestone of the Espee Formation forms prominent cliffs or ribs between recessive lithologies of the Tsaydiz and Stelkuz formations, and is an excellent marker horizon within the Cassiar Terrane (Photo 2). Structural sections suggest thicknesses between 250 and 450 metres. The unit is characterized by grey to buff weathering, platy and blocky, finely recrystallized limestone and dolomitic limestone. Sections of thinly interlayered limestone and more resistant, orange weathering dolomite or dolomitic limestone are also common. Bedding is typically difficult to distinguish and the grey to buff weathering limestone commonly appears massive. Where visible, beds can be up to a metre thick and are typically discernible through platy, phyllitic partings, as thin grey slaty interlayers, or wispy, darker grey streaks. Grey, calcareous slate in layers 0.5 to 3 centimetres thick is interlayered with the limestone in several localities. Large cross-cutting zones of orange weathering, coarsely recrystallized dolostone can be found within the limestone succession. Up to several per cent dispersed quartz grains were observed within some horizons north of Wrede Creek.

### *Stelkuz Formation*

Regionally, the Stelkuz Formation contains thick sections of sandstone, limestone and slate (Ferri and Melville, 1994; Ferri *et al*., 1993a; Mansy and Gabrielse, 1978). In the present map area it is dominated by rusty brown weathering, greenish grey slate with lesser thin to massively bedded cream impure quartzite and quartz sandstone in sections up to 20 metres thick and thinly bedded, grey limestone. Slate sections can display a distinctive bright green colour typical of the Stelkuz Formation (Ferri *et al*., 1993a). The dominance of slate renders this unit quite recessive and poorly exposed (Photo 2). Structural sections suggest thicknesses between 175 and 550 metres.

## Big Creek Group

The Big Creek Group is dominated by dark grey and black slate and argillite with minor quartz-chert wacke, sandstone, felsic and mafic volcanics and limestone. Volcanics towards the top of this unit are locally referred to as the Gilliland Tuff (Ferri and Melville, 1994). Due to the abundance of slate in this unit it is typically very recessive and poorly exposed, occupying valley floors (Photo 2).

The age of the Big Creek Group is thought to be Early Devonian to Early Permian in age (Ferri and Melville, 1994). Generally Late Devonian to Early Mississippian ages are indicated by fossils and U/Pb ages consistent with dates from other members of the Earn Assemblage (Ferri and Melville, 1994). Locally, as in the Nina Lake area, slates in the upper part contain Early Permian fossil assemblages (Ferri and Melville, 1994). In the Aiken Lake area, rocks of the Middle Devonian Otter Lakes Group are not present and slates assigned to the lower Big Creek Group contain conodonts as old as Emsian (Late Early Devonian).

This Big Creek Group is characterized by carbonaceous, dark grey to blue grey weathering, dark grey to black slate which can be interlayered with thinly bedded argillite or siltstone. The blue-grey colour, together with a distinctive yellowish stain on weathered surfaces, is typical of Late Devonian Earn Assemblage rocks found throughout the northern Cordillera. The slate can be quite friable and locally breaks into large, flexible sheets. Slate in the lower part of the unit is more lustrous and has a dark grey-brown colour.

Near the base of the Big Creek Group, rare 1 to 5 metres sections of grey to brown weathering, grey, thinly bedded carbonaceous limestone and argillaceous limestone occur interlayered with slate. Dark grey weathering, platy, recrystallized limestone with slate and silt partings up to 3 metres thick, is sporadically encountered towards the top of the unit.

### *Coarse Clastics*

Lenses of coarse siliciclastics from 5 to more than 40 metres in thickness are found within the upper part of the Big Creek Group and are composed predominantly of chert-quartz wackes to sandstones, conglomerates and siltstones. Although these coarse units comprise only a minor component of the Big Creek Group, their composition has implications for the tectonic evolution of the northern Cordillera. Workers in the northern Cordillera believe that these northerly and westerly derived clastics were shed from uplifted blocks due to a regional rifting event during the Late Devonian (Gordey *et al*., 1987). Mapping in the southern Cordillera, primarily within the Roberts Mountain Allochthon, has shown that contractional deformation was occurring during this time period along the present southwestern margin of Ancestral North America. This has led some to interpret the Earn Assemblage as a foredeep and the associated coarse clastics as representing material shed from easterly thrusted fault blocks (Smith *et al*., 1993).

These coarse clastics form a section over 40 metres thick on the north side of Wrede Creek and are locally graded granule conglomerates. Wackes within these and other sequences contain between 20 to 40 per cent dark

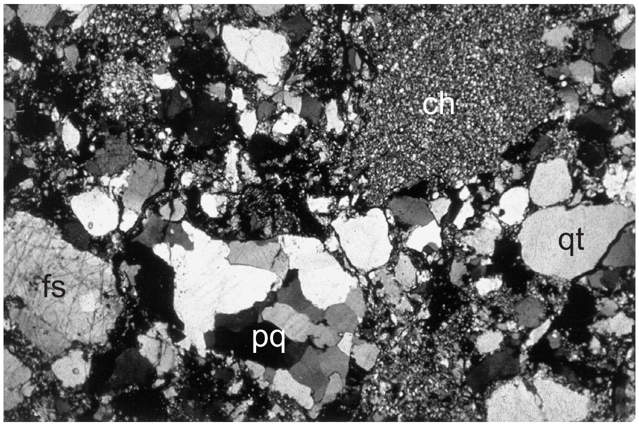

Photo 3. Photomicrograph of coarse clastics within the Big Creek Group. This sample originated from the south end of the Ingenika Range. Width of the photo represents 4.5 millimetres. fs: feldspar, ch: chert, qt: quartz, pq: polygonal quartz.

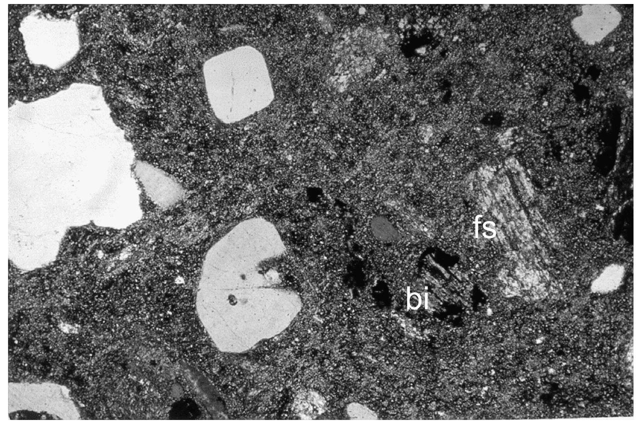

Photo 4. Photomicrograph of felsic volcanics of the Gilliland Tuff from the northern Lay Range. Note the embayed nature of the quartz phenocrysts. Textures visible in outcrop suggest this volcanic is tuffaceous. Cleavage orientation is parallel to the length of the photo. Width of the photo represents 4.5 millimetres. bi: biotite, fs: feldspar.

muddy matrix. Even the 'cleaner' sandstones contain up to 10 per cent dark grey to black argillaceous matrix giving them a dark colour. Clasts can be angular to rounded, although they are typically subangular to subrounded (Photo 3). Quartz, either as single or polygonal grains, usually is the dominant constituent comprising up to 60 per cent of grains and clasts. Light and dark grey to black chert is the next most dominant clast-type forming up to 30 per cent of grains. Minor clasts include siltstone and sandstone (approximately 10 per cent) and plagioclase (1-2 per cent). One section of sandstone contained up to 40 per cent plagioclase and orthoclase? clasts, suggesting it was produced, in part, from the weathering of an igneous protolith.

## *Volcanics*

Felsic and mafic volcanic units from 1 to more than 45 metres in thickness are found stratigraphically above the coarse siliciclastics, within the upper-most part of the Big Creek Group. These are identical to those found regionally within the Big Creek Group and referred to as the Gilliland Tuff (Ferri and Melville, 1994).

### Gilliland Tuff

Felsic tuff and massive porphyry (flows or sub-volcanic intrusives) are best developed in the extreme southeastern part of the project area where it forms a sequence over 45 metres thick (Figure 3). The unit is also encountered north of Wrede Creek where it ranges from 1 to 5 metres in thickness (Figure 3). It is typically light grey-green or rusty weathering sericitic quartz-feldspar tuff and/or porphyry. The unit contains sections of lapilli and coarse lapilli tuffs in the southeastern part of the map area (Figure 3). Phenocrysts comprise 5 to 20 per cent of the rock with embayed quartz crystals being the most common followed by plagioclase and poorly preserved accessory minerals. The latter have been altered to chlorite plus opaques, but in several instances residual material, together with pseudomorphs, suggests these were predominantly hornblende. The groundmass consists of sericite, quartz, feldspar plus chlorite, carbonate and opaques. Rip ups of black argillite from the surrounding sediments are locally abundant. Fine grained tuff invariably displays a weak to strong cleavage, although massive porphyry appears relatively undeformed (Photos 4 and 5). Chemical analysis of the tuff collected during the Manson Creek and Aiken Lake projects suggests these rocks are calc-alkaline in composition and are generally rhyolites to rhyodacites, (Ferri and Melville, 1994).

### Mafic Volcanics

In the southern part of the map area, basalt and quartz-diorite is exposed at roughly the same stratigraphic horizon as the Gilliland Tuff. Pillowed? or fragmental basalt was observed in one locality and formed lenses and semi-continuous horizons approximately 50 centimetres thick within Big Creek argillites. The massive basalt is dark green and aphanitic with minor


Photo 5. Photomicrograph of felsic volcanics of the Gilliland Tuff from the Wasi Lake area. This sample is very similar to that shown in Photo 4 except that it lacks a penetrative cleavage. Texturally this rock looks like a quartz-feldspar porphyry flow or sub-volcanic intrusion. Width of the photo represents 4.5 millimetres.

calcite veining. Thin section examination reveals a predominance of finely crystalline feldspar together with carbonate, chlorite, sericite and opaques.

A few kilometres southeast of the basalt occurs a horizon of greenish grey quartz-diorite and crowded quartz-feldspar porphyry. The unit is approximately 15 to 20 metres thick and can be traced laterally into dark grey argillites of the Big Creek Group. Green slates are found within the argillites in the vicinity of these mafic rocks. Thin section examination from the periphery reveals it is composed of 30 to 50 per cent coarsely crystalline and sericitized plagioclase, 10 per cent quartz, with the remainder being finely crystalline feldspar, quartz, opaques and up to 30 per cent chlorite. This finer groundmass displays a strong, ductile flattening fabric whereas the large plagioclase phenocrysts behaved brittly and are merely broken. Preliminary lithogeochemical analysis suggests this rock is intermediate in composition.

The precise age of the Gilliland Tuff is poorly constrained. Stratigraphically it is found towards the top the Big Creek Group suggesting it is Mississippian or younger in age. U/Pb geochronology on a zircon collected at the type locality indicated a minimum age of 377±12 Ma (Ferri and Melville, 1994). A sample collected on the west bank of the Osilinka River returned a preliminary minimum age of 342±3 Ma (J. Gabites, personal communication, 1993). The age reported for both samples is based on a least square regression line as there were no concordant fractions in either sample due to inheritance and/or lead loss.

Although this data suggests there may be two periods of volcanism, the similarity between the volcanics suggests otherwise and the discrepancy is probably based on the poor U/Pb systematics within the collected zircons. At present the best estimate on the age of the Gilliland Tuff is Late Devonian to middle Mississippian. More samples were collected this summer in hopes of refining the age of this unit.

### *Nature of the Big Creek - Stelkuz Contact*

In the map area, the Big Creek Group sits directly above the Stelkuz Formation and intervening strata of Early Cambrian to Middle Devonian age are missing (Figure 4). Due to the relatively recessive nature of these two units, the contact was not exposed; no direct observations could be made on the nature of this contact. The possibilities for the lack of intervening stratigraphy include: a steep normal fault; an unconformity or a shale-out of the missing carbonate-dominated stratigraphy.

Mapping in the southern part of the study area initially suggested the presence of a late normal fault offsetting stratigraphy. Although locally this seems possible, the position of the Big Creek above Stelkuz lithologies would require a very persistent normal fault whose stratigraphic and/or structural displacement remains constant over 25 kilometres - a situation that seems rather unlikely.

Missing stratigraphy below the Big Creek Group was also observed in the southern Lay Range during part of the Aiken Lake Project. In this area, rocks of the Echo Lake Group disappear north of the northeast-trending Knoll normal fault, such that Big Creek rocks sit directly above the uppermost Atan Group (Ferri *et al*., 1993a, b). The presence of a normal fault was also postulated by Ferri *et al*. (1993a) in this area, although stratigraphic evidence suggested that the Early Paleozoic carbonate sequence in this area may be shaling out to the north. A more detailed account of this can be found in Ferri *et al*., (1993a).

Although a shale-out of the missing stratigraphy is a possibility, an unconformable contact at the base of the Big Creek Group is presently favoured and is consistent with the present data. In the western Selwyn Basin, rocks of the Earn Assemblage are found unconformably overlying units as old as Late Proterozoic (Gordey and Irwin, 1987), a situation similar to that postulated here.

### *Extensions of the Big Creek Group Beyond the Map Area*

Rocks of the Big Creek Group most likely extend beyond the northern limit of the present mapping project, and are probably traceable up to the Ingenika Fault where rocks of Ancestral North America are juxtaposed against volcanic rocks of Quesnellia (Gabrielse *et al*., 1977). Although Big Creek rocks are not displayed on regional maps of this area (McConnell Creek East-Half; Richards, 1976 and Ware West-Half; Gabrielse *et al*., 1977), the northward continuation of the Stelkuz Formation at the contact with the Lay Range Assemblage, taken in conjunction with the recessive nature of the Big Creek Group, suggests its presence may be masked by overburden. This is supported by the trace of several large creeks which have followed this relatively incompetent horizon.

Southeast of the Manson River, in the Pine Pass map area, Struik and Northcote (1991) traced rocks similar to the Big Creek Group, assigning them to the Earn Group. They also described tuff and minor basalt within this sequence. Struik (1989) also reported felsic tuff up to 300 metres thick within dark grey argillites of Late Devonian age within the McLeod Lake map area. These are found east of the McLeod Lake fault zone and west of the Northern Rocky Mountain Trench fault zone and are probably more akin to the Besa River Formation. Struik (1990) suggests that this block of Ancestral North American stratigraphy is transitional between typical carbonate platform sequences observed to the west and more basinal successions found east of the McLeod Lake fault zone.

## Lay Range Assemblage

The Lay Range Assemblage has been subdivided into two broad packages: the Lower Sedimentary Division (LSD) and the Upper Mafic Tuff Division (UMTD) (Ferri, 1997). The LSD is a mixed sedimentary and volcanic sequence whereas the UMTD is almost entirely fine and coarse grained mafic tuffs, volcanic breccia and flows (Figure 5).

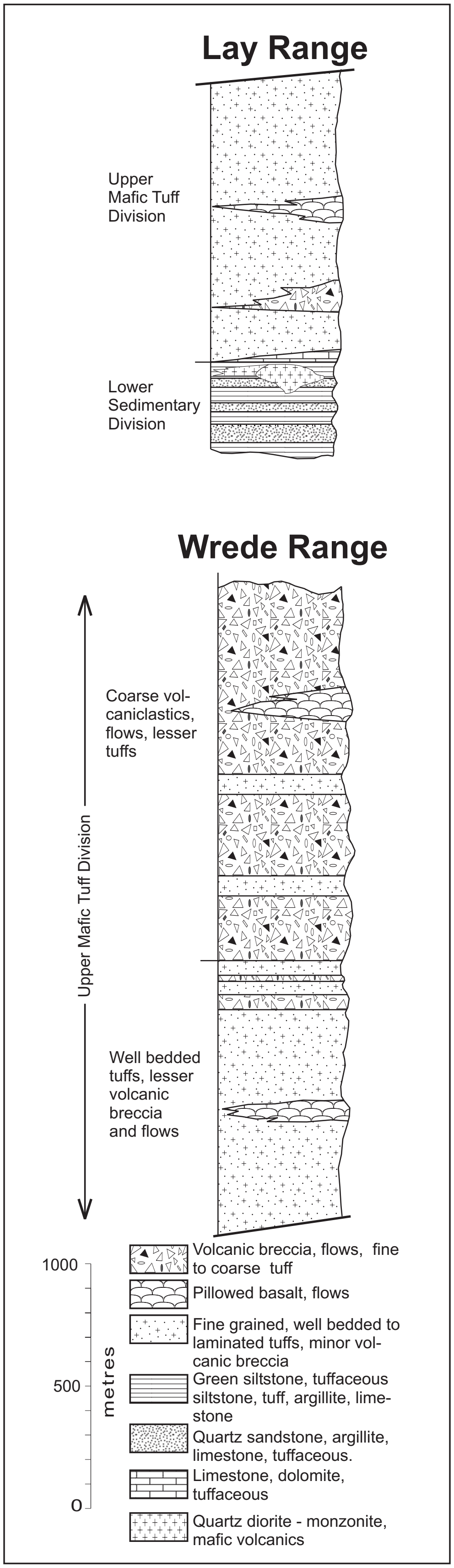


Figure 5. Simplified stratigraphic columns of the Lay Range Assemblage within the map area.

The age of the Lay Range Assemblage is late Mississippian (Namurian) to Permian based on fossil collections made in the southern Lay Range (Ferri, 1997). Conodonts, corals, fusulinids and foraminifera recovered from the LSD suggest a late Mississippian lower age limit and a middle Pennsylvanian upper age limit for limestone at the top of the unit. Radiolarians from chert within the green and maroon siltstone and tuff unit above this limestone have indicated Early Permian ages. Conodonts from the remaining UMTD are broadly Permian in age. In the southern part of the Lay Range tuffs of the UMTD were believed to sit unconformably on the limestone below the green and maroon siltstone suggesting an unconformity of some 13 Ma between the two units (middle Pennsylvanian to Early Permian; Ferri, 1997). Stratigraphic relationships observed within the present map area suggest the limestone and UMTD have a conformable relationship. Although these two interpretations may seem at odds, this is entirely consistent with the variability observed along volcanic arcs.

### *Lower Sedimentary Division*

The LSD is only exposed within the northern Lay Range, in the southeastern portion of the map area (Figure 3) and is restricted to the core of a north-east verging fold (Ferri, 1997). Generally, siliciclastics and carbonates are found within the lower parts of this package with mafic volcanics becoming dominant towards the top. The entire sequence is capped by a limestone up to 50 metres thick.

The lower parts of the LSD are characterized by interbedded quartz sandstone, argillite, siltstone, chert and tuff. Sandstone forms prominent weathering ribs 5 to 15 metres thick within this section and comprises approximately 30 per cent of the sequence. Laterally they appear to pinch out within green siltstone and tuff. Thin to thick or massively bedded sandstone to granule conglomerate is beige weathering and grey in colour. Compositionally it is an impure quartz sandstone and locally contains clasts of feldspar and lithic fragments. The matrix typically is calcareous and greenish, the latter suggesting it is partly of volcanic origin.

Interbedded argillite or slate is dark grey and is associated with platy dark limestone and dark grey to cream, thin to thickly bedded chert. Associated with all these lithologies is green to maroon siltstone grading into tuff which makes up to 50 per cent of the section.

On the eastern limb of the overturned anticline, the upper part of the LSD is intruded by a greenish-grey quartz-diorite to monzonite up to several hundred metres thick. This unit can be spatially associated with grey-brown weathering, dark green aphanitic basalt and brown to orange weathering, green feldspar-pyroxene porphyry. Above these rocks is a distinctive package of interlayered green and maroon siltstone, tuff and jasperoidal chert up to 20 metres in thickness. This unit is commonly associated with limestone and is found at the contact with tuffs of the UMTD. The distinctiveness of this unit and its presence at the LSD - UMTD contact make it a local marker horizon.

Lenses of buff weathering, cream coloured, recrystallized massive dolomite, with layers of green slate, up to 20 metres in thickness is commonly found below the green and maroon siltstone. This dolomite horizon forms a semi-continuous unit which, together with the succeeding limestone, can laterally pinch-out over short distances (Figure 3; Photo 6). Massive to platy grey limestone up to 50 metres thick, with distinctive ribs of beige to light grey wavy chert lenses 1 to 5 centimetres thick can be found stratigraphically above the green and maroon siltstone unit. Although the limestone contains a very strong fabric, textures are preserved locally; some parts are bioclastic with poorly preserved crinoid ossicles and fusulinids (J.W.H. Monger, unpublished notes, 1973). Sections of the limestone are tuffaceous and have a maroon and green colour. Interbeds of green tuff between 10 to 50 centimetres thick are also present. The lower contact of the limestone appears gradational with the underlying green and maroon siltstone. The upper part of the limestone displays a sharp, but interbedded contact with tuffs of the UMTD. This limestone interfingers with tuffs of the UMTD along ridge faces (Photo 6). Its thickness changes drastically to less than a metre in the far southeastern portion of the map area. There, maroon and green siltstone, tuffs and chert are found on either side of the limestone unit, a relationship also observed several kilometres to the north where the limestone thickens to 50 metres.

Two bands of limestone are present along the top of the eastern extent of the LSD. Although they appear to be two separate units, they are remarkably similar and the recurrence of the distinct maroon and green unit, together with the monzonite and tuff, indicates a structural repetition.

### *Upper Mafic Tuff Division*

The UMTD is a relatively homogenous package dominated by thin to massively bedded tuffs with lesser lapilli tuffs, volcanic breccia, basalt, diorite and rare quartz-feldspar tuff or porphyry flows. Thinly bedded tuffs are typically laminated and commonly graded. Rocks of the UMTD are found on either side of the northeast verging, overturned anticline within the northern Lay Range. They can be traced to the north, along the subdued valley east of the Wrede Ultramafic Complex and across Wrede Creek where they form the high ground along the northwestern part of the map area. South of Wrede Creek, graded, well bedded tuffs (Photo 7) are the most common lithology along the east side of the anticline, with massive basalt flows accounting for approximately 10 per cent of the lower and middle section.

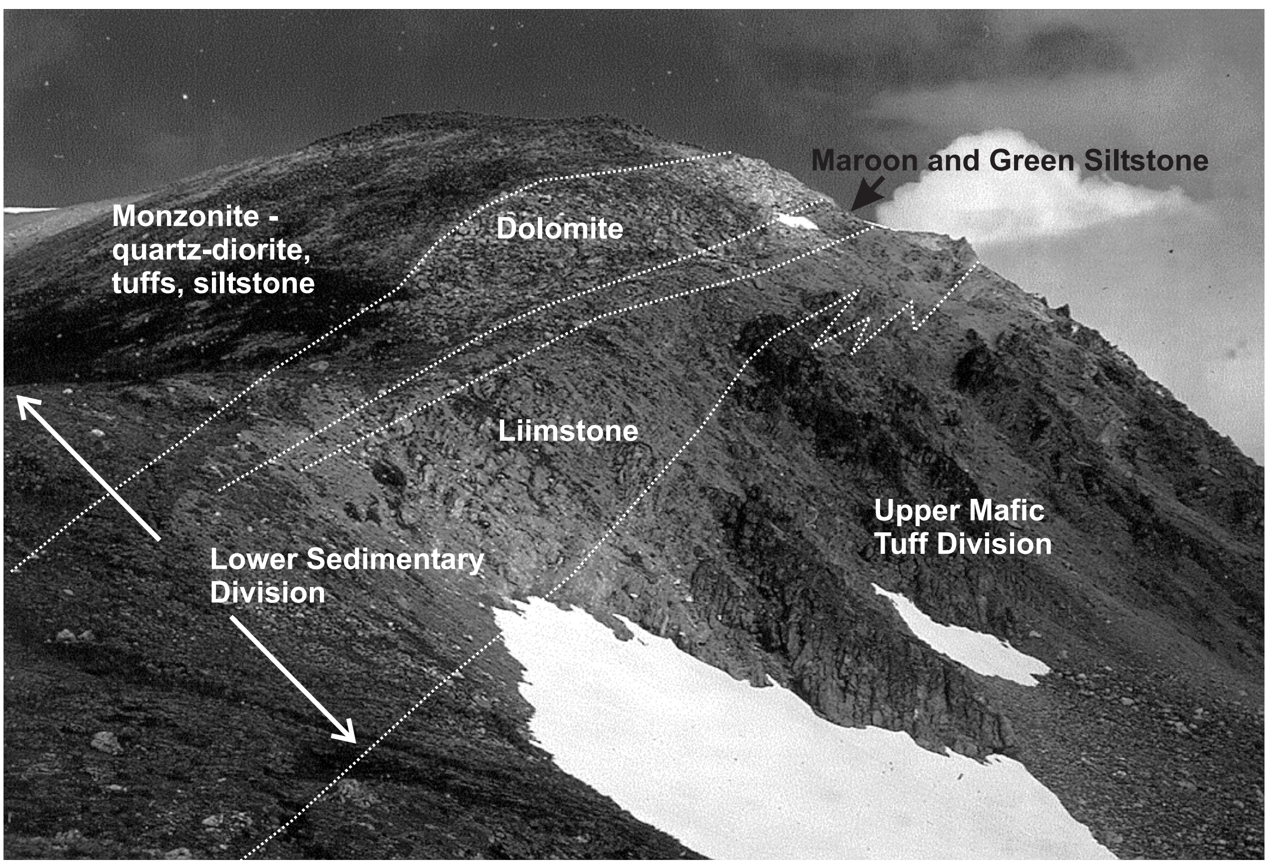


Photo 6. Looking southeast at the contact between the UMTD and LSD of the Lay Range Assemblage along the northern Lay Range. The interfingering between the limestone at the top of the LSD and tuffs of the UMTD has been highlighted. Also shown is the horizon of maroon and green siltstone/tuff which sits stratigraphically below the limestone at this locality but can also be found between it and the UMTD elsewhere, a configuration also observed in the southern Lay Range (Ferri, 1997).

Photo 7. Photograph of typical well bedded and laminated fine grained, graded tuffs of the UMTD. This is the most common lithology observed within the UMTD.

A rare occurrence of rusty weathering, light greenish grey quartz-feldspar sericite schist (originally tuff or porphyry flow), approximately 20 metres thick (*see* Figure 3), was encountered within this unit on the northeast flowing creek immediately north of the Lay Range. This unit was sampled for U/Pb and whole rock analysis. The UMTD is much coarser on the southwest side of the anticline within the Lay Range where it is composed of green and dark green fine to coarse grained lapilli tuffs, volcanic breccias and massive basaltic flows. Volcanic clasts are commonly flattened parallel to cleavage and consist of aphanitic and amygdaloidal basalt. Dark grey and black argillite clasts and quartz grains also form accessories in certain horizons. A rare, small rubbly outcrop of orange-brown coarse grained quartz-feldspar sandstone was observed within this succession.

North of Wrede Creek, the UMTD is found within an upright, steeply southwest dipping panel with the graded, laminated, fine tuffs in the stratigraphically lowest part of the panel (eastern lower slopes) and these are succeeded by lapilli tuffs, volcanic breccias and flows (Photo 8). The contact between the two is gradational with a general coarsening of the volcanic deposits up section until over 50 per cent of the sequence is composed of lapilli tuffs and/or volcanic breccia.

Clasts within the volcanic breccia unit are more diverse than observed south of Wrede Creek. They are typically green to maroon in colour and consist of aphanitic basalt together with fragments of pyroxene and/or feldspar porphyry basalt. Deposits can be monomictic to polymictic and are locally associated, especially towards the top of the ridge, with massive to pillowed basalt of similar composition. Some feldspar porphyry flows are quite distinctive due to the presence of phenocrysts up to several centimetres in size. The coarse volcaniclastics are locally intruded by small bodies of hornblendite and associated gabbro probably related to the Wrede Ultramafic Complex.

Correlations of the Lay Range Assemblage with other packages throughout the Cordillera have been summarized by Ferri (1997). Intermixed sediments and volcanics of the LSD have the greatest potential of being equivalent to rocks of the Yukon-Tanana Terrane which host VMS occurrences. The oldest age known from the Lay Range Assemblage consists of late Mississippian to early Pennsylvanian conodonts recovered from the lower parts of the unit in the southern Lay Range. This is somewhat younger than the Early Mississippian age for quartz-feldspar meta-porphyry associated with the Wolverine deposit (Murphy and Piercey, 1999). As well, the overall character of the LSD is different than that of the Yukon-Tanana Terrane in the Finlayson Lake area. In general, rocks of the LSD and UMTD correlate with the middle and upper parts of the Dorsey Assemblage as de-

Photo 8. Polymictic volcanic breccia of the UMTD. This lithology occurs in the lower part of the UMTD within the Wrede Range and is characterized by maroon and green clasts of aphanitic basalt together with pyroxene and/or feldspar phyric basalt.

scribed by Stevens and Harms (1995) along the B.C. - Yukon border and further south by Nelson (1997).

## Takla Group

The Takla Group was observed in only a handful of outcrops south of Wrede Creek. Regionally Takla rocks sit unconformably atop those of the Lay Range Assemblage (Ferri, 1997). A steep fault zone, of possibly strike-slip configuration, separates the two packages within the present map area.

Rocks of the Takla Group consists of augite-feldspar porphyry flows, pyroclastic breccia and tuff, all of which have become sheared and foliated near their contact with the Lay Range Assemblage. Small stocks of beige quartz monzonite locally intrude these volcanics.

The Takla Group is Late Triassic to Early Jurassic in age immediately to the south (Ferri and Melville, 1994; Ferri *et al*., 1992b, 1993b). Augite-plagioclase phyric volcanics observed within the map area belong to a sequence locally referred to as the Plughat Mountain Succession (Ferri and Melville, 1994) which is broadly Late Triassic in age.

## Wrede Ultramafic Complex

The Wrede Ultramafic-Mafic Complex is an Alaskan-type body of Late Triassic age intruding rocks of the Takla Group just south of Wrede Creek (Figure 3; Nixon *et al*., 1998). The complex is crudely zoned with a gradation from dunite in the core to gabbro at the margins. These rocks were not examined in any detail; the geology of the complex shown on Figure 3 is taken from Nixon *et al*. (1998). This ultramafic body is most likely related to the Polaris Ultramafic Complex which intrudes rocks of the Lay Range Assemblage within the southern part of the Lay Range (Nixon *et al*., 1998; Ferri *et al*., 1993a, b).

## STRUCTURE AND METAMORPHISM

The structural style within the map area is quite variable and is a reflection of the different tectonic terranes present. Generally, the degree of penetrative deformation increases from west to east within the map area. Cleavage is poorly developed or non-existent within coarse volcanic breccias and flows of the UMTD and Takla Group. When present, a weak cleavage within coarse volcaniclastics of the UMTD is one of the criteria used in distinguishing these rocks from similar, but relatively undeformed volcaniclastics in the Takla Group. Commonly a slaty cleavage is present within rocks of the underlying Big Creek Group and the fine tuffs of the UMTD. The intensity of cleavage and metamorphism increases down section, into rocks of the Ingenika Group where well developed, biotite-bearing schists occur in the lower parts of the Swannell Formation. Although biotite porphyroblasts were noted in several localities along the eastern margin of the map area, not enough data points are available to draw a metamorphic isograd. At one locality poikiloblastic biotite porphyroblasts were up to several

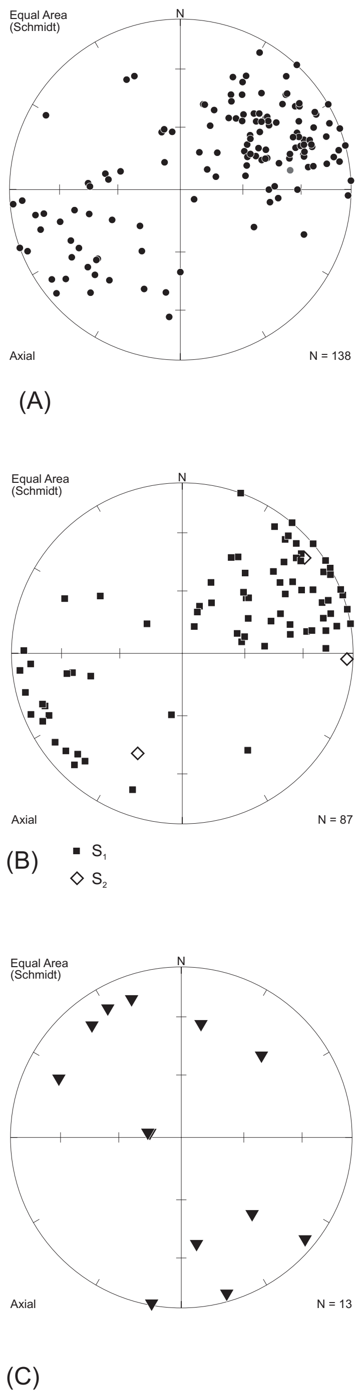


Figure 6. Equal area plots of structural data from the map area. (A) Poles to bedding. (B) Poles to cleavage. (C) Bedding-cleavage intersections.

millimetres in length. Although they grew in a random to semi-random orientation, they were produced near the end of $S_1$ cleavage development as shown by the slight wrapping of this fabric around the porphyroblasts.

Metamorphism is of regional or Barrovian-type and dating of metamorphic minerals indicates it is Middle Jurassic in age, although mid-Cretaceous and Tertiary cooling ages are also encountered (Ferri and Melville, 1994).

Only one large scale fold was delineated within the map area and consists of a tight, northeasterly overturned structure outlined by the limestone marker between the UMTD and LSD (Figure 3). This large fold is the northward continuation of a structure mapped within the southern Lay Range (Ferri *et al*., 1993a, b). The southwest dipping axial plane of this fold is similar in orientation to the average attitude of cleavage within rocks of the map area (Figure 6). The fold structure is lost north of the Lay Range and only a southwest dipping overturned panel of volcanics belonging to the UMTD occurs north of the Wrede Ultramafic Complex, suggesting the core of the structure is located further to the west. The repetition of the limestone at the top of the LSD along the eastern limb of the structure is believed to be due to small scale folding. Outcrop-scale versions of this large fold were observed primarily within rocks of the Swannell Formation.

Early cleavage, together with the surrounding lithologies, is locally broadly folded and/or crenulated. This folding is best developed within rocks of the Swannell Formation, although the spread of cleavage orientation shown in Figure 6 indicates the entire map area has been affected. This suggests the presence of at least two distinct periods of fold formation. Cassiar rocks within the map area are found on the west flank of a broad antiform similar to others developed within strata of the Ingenika Group (Figure 2). It is not clear if the latter, upright folds within the map area are related to these structures or represent a distinct fold episode. Comparison of bedding-cleavage intersection attitudes and the beta direction for poles to cleavage and bedding within the map area suggest the two fold styles are coaxial.

The large, northeasterly overturned fold within the Lay Range Assemblage is carried in the hangingwall of the major, terrane bounding, northeasterly directed thrust (Swannell Fault; Wheeler and McFeely, 1991), which places rocks of the Lay Range Assemblage above those of the Cassiar Terrane. The thrust is steeply dipping to the southwest and is roughly parallel to bedding in bounding units. This thrust delineates the western boundary of Ancestral North American rocks within this part of the Canadian Cordillera. Although no kinematic indicators were observed in the map area, in the southern Lay Range these display tops to the east directions (Nixon *et al*., 1993; Ferri *et al*., 1993b). It is interesting to note that in the most northern part of the map area folding of the fabric along this zone, in conjunction with brittle pull-aparts, would suggest late strike-slip motion, possibly dextral in nature. The axial planes of these folds are steep and perpendicular to the fault contact and the associated fold axes also exhibit steep plunges. These structural features were localized and their regional significance is presently unknown.

The contact between the Lay Range Assemblage and the Takla Group is marked by a steeply dipping zone of highly sheared volcanics up to 100 metres wide. Regionally, the Lay Range Assemblage has been shown to form the basement to Takla volcanics (Ferri, 1997). The fault zone can be quite narrow, as observed in the northern Lay Range where it is hidden below approximately 10 metres of glacial deposits. Typically the zone is marked by a steep cleavage or schistosity with relic pyroxene, feldspar or lithic clasts. Deformation appears ductile, although certain components, such as feldspar and pyroxene, behaved quite brittly. No kinematic indicators could be discerned where the fault zone was examined in the map area.

In the southern part of the map area the fault zone trends north-northwesterly. It cuts out much of the Lay Range Assemblage as it is traced northwards towards the Wrede Range (Figure 3). It is likely the fault veers more to the west across Wrede Creek due to the increased amount of Lay Range volcanics and the lack of large shear zones within Lay Range rocks.

This steep dipping fault structure probably connects southwards with either the Polaris Creek or Lay Range fault zones, two strike-slip fault zones with several kilometres displacement (Ferri *et al*., 1993b; Ferri, 1997). These faults are part of an en echelon fault array that together with the Manson fault zone and Pinchi and Northern Rocky Mountain Trench systems, record a major period of Late Cretaceous to Early Tertiary dextral motion in this part of the Cordillera.

## MINERAL POTENTIAL

The Earn Assemblage, to which the Big Creek Group belongs, is an important metallotect within the Canadian Cordillera. In Selwyn and Kechika basins, it hosts significant SEDEX deposits such as the Tom, Jason, Driftpile Creek, Akie and Cirque. Further west, Earn Assemblage rocks also contain important VMS deposits which include the Marg of northwestern Selwyn Basin and the Wolf deposit found within the northern Cassiar Terrane.

In southeastern British Columbia rocks of similar age to the Earn found within the western Kootenay Terrane, a more distal part of the ancient continental margin, also hosts important VMS deposits such as Rea and Homestake. Finally, Early Mississippian rocks of continental nature, but uncertain affinity within the Yukon-Tanana Terrane, have recently been shown to contain large VMS deposits including the Wolverine, Kudz Ze Kayah and Fyre Lake. As stated earlier, all these occurrences taken together underlines the fact that the Late Devonian to Early Mississippian is an important period of metalliferous deposition.

Major SEDEX mineralization within the Selwyn and Kechika basins are Frasnian and Famennian (Late Devonian) in age (Paradis *et al*., 1998) and found towards the base of the Earn Group. SEDEX occurrences of Early Mississippian age are reported in the MacMillan Pass area of the Selwyn Basin (Irwin and Orchard, 1989). The ore composition of these deposits is simple, being made up of sphalerite and galena (+silver) with pyrite and barite as non-ore components. Barite is an important constituent of these occurrences and is commonly found in distal parts of the deposits or as the primary component of low-temperature systems. The presence of barite by itself within Earn lithologies is important in that it signifies the presence of active exhalative systems.

In the Yukon, VMS deposits within Earn rocks are associated with calc-alkaline and alkaline to calc-alkaline felsic volcanics. The Wolf deposit is found with the alkaline to calc-alkaline Pelly Mountain volcanic belt which is associated with several other VMS occurrences including the MM, Mamu, Bnob, Chezpnough and Tree (Hunt, 1999). Mineralogically these are composed of sphalerite, galena (+silver), minor copper, and with pyrite, pyrrhotite, barite and minor fluorite as accessories. The age of these deposits is uncertain and are broadly Late Devonian to Early Mississippian (Hunt, 1999).

The Marg VMS deposit of northwestern Selwyn Basin is associated with calc-alkaline felsic volcanics of Early Mississippian age (Turner and Abbott, 1990). This is a polymetallic occurrence composed Cu, Zn, Pb, Ag and Au with a sulphide mineralogy made of pyrite, chalcopyrite, sphalerite, galena and minor tetrahedrite and arsenopyrite. Ferroan carbonates and quartz are also important constituents of the ore body. The presence of sericite-carbonate-quartz-pyrite within footwall rocks suggest hydrothermal alteration, a situation rarely seen within the low temperature SEDEX deposits or reported from the Pelly Mountain alkaline occurrences.

### Mineral Potential of the Big Creek Group and Gilliland Tuff

Known mineralization within the Big Creek Group is SEDEX in nature although there are anomalous stream sediment and soil geochemistry localities suggesting the potential for mineralization within the Gilliland Tuff. SEDEX mineralization is found at the Omineca Queen bedded barite occurrence and in the Wasi Lake area.

#### *Sedex Mineralization*

The Omineca Queen (MINFILE number 093N 087) bedded barite, located near Munro Creek, immediately south of the Manson River, is the only documented SEDEX occurrence within the Big Creek Group (Figure 2; Band, 1970; McCammon, 1975; Craig, 1992). The Omineca Queen consists of up to 7 metres of bedded to massive barite hosted within dark grey argillites and slates. This SEDEX occurrence was visited to examine the mineralization and its possible relationships to the Gilliland Tuff. Old trenches and cat trails are severely overgrown and only two sections of massive to poorly bedded barite up to 3 metres thick were visible. Although no felsic tuff was observed in the area, mapping showed that the barite is found within black, fissile shale to argillite and sits stratigraphically below quartz-chert wackes and sandstone which regionally are below the Gilliland Tuff. This barite mineralization is probably part of the Late Devonian SEDEX event found throughout the Kechika and Selwyn basins of Ancestral North American.

Exploration by Cominco Exploration Ltd. east of Wasi Lake, near the former PAR mineral claims, discovered several other barite occurrences within the Big Creek Group (Bruce Mawer, personal communication, 1993). In this area, Big Creek argillites can be traced around a broad syncline south of the Osilinka River (Figure 2). East of Wasi Lake, anomalous levels of Pb, Zn and Ba in stream silts were reported by Ferri *et al*. (1992a) and from the RGS survey for 94C (Jackaman, 1998). Anomalous stream sediments and soils were also collected on the former RAP mineral claims (Johnson, 1996) which are several kilometres northeast of Wasi Lake. Together, these indicate the potential for SEDEX style mineralization within the Big Creek Group of the Wasi Lake area. Rock geochemistry on several samples of the lower Big Creek Group indicate weakly anomalous Ba levels in one area and elevated levels of Ag (2.6 ppm), Pb (433 ppm) and Ba (1928 ppm) in another area (Johnson, 1996).

### *Potential for VMS Mineralization*

Mapping by the author has traced Gilliland Tuff felsic volcanics from the Manson River area to the Wrede Range, a distance of some 150 kilometres (Figure 2). These volcanics are intermittently present within the upper part of the Big Creek Group and are from several metres to some 50 metres in thickness. Textural features commonly indicate the volcanics are tuffaceous and submarine in nature, being interbedded with fine clastics of the Big Creek Group. Sections in several localities are quite thick and parts of the unit appear to be subvolcanic and texturally resemble a quartz ±feldspar porphyry intrusion. Areas where thick volcanics occur include: the type locality around Germansen Landing; the area south of the Swannell River and the region between the Osilinka River and Wasi Lake where the unit is well in excess of 1000 metres thick. The mapped extent of the volcanics shown in Figure 2 would suggest that a volcanic centre may be present in the Wasi Lake area with subsidiary centres in the Germansen Landing and Swannell River areas. The thin horizons of tuff seen elsewhere within the Big Creek Group would then represent distal deposits produced by these or other volcanic centres.

Although no mineralization has yet been attributed to this unit, several drainages cutting the Gilliland Tuff have returned anomalous stream silt geochemistry and anomalous whole rock geochemistry for the tuff. In the Wasi Lake area, the recent RGS release for NTS sheet 94C (Jackaman, 1998) contains localities with anomalous levels of Pb, Zn, Ba and ±Au for some of the drainages cutting the unit. Rock sampling of carbonaceous breccia or conglomerate from the Gilliland Tuff within the former RAP mineral claims east of Wasi Lake returned anomalous Ag (7.3 ppm) and Ba (greater than 2000 ppm; Johnson, 1996). Gilliland volcanics in the Wasi Lake area locally contain sericite and/or carbonate alteration.

South of Swannell River, several drainages cutting the Gilliland Tuff contain silts with anomalous levels of Cu (24, 104 and160 ppm), Pb (10, 26 and 107 ppm) and Zn (283, 1090 and 1453 ppm; Rhodes, 1994). Silts from several streams cutting the Big Creek Group in the northern Lay Range (Figure 3) contain sediments slightly anomalous in Pb, Zn and Ba (Jackaman, 1998).

The high background level of barium in the Gilliland Tuff, together with the associated barite in some of the VMS occurrences in the Pelly Mountains suggests that this mineral can be, as in the case of SEDEX deposits, a useful indicator of nearby mineralizing systems. Bedded barite of Early Mississippian age is known from the Selwyn Basin and northern Cassiar platform and may be time equivalent to some of the felsic volcanism (Gordey, 1991; Irwin and Orchard, 1990).

## SUMMARY

In summary, mapping in north-central British Columbia has delineated the presence of a Late Devonian to Early Mississippian sequence of argillite, slate and sandstone with proven SEDEX potential. The upper part of this succession also contains felsic tuff similar in age and general composition to volcanics in cratonic and pericratonic rocks which are associated with VMS mineralization. These volcanics, locally called the Gilliland Tuff, have been traced from the Manson River area to as far north as Wrede Creek, a distance of some 150 kilometres. Although no direct mineralization was observed within these rocks, anomalous base metals values in silt samples from several drainages cutting these rocks together with elevated base metals in rock analysis suggests the potential for VMS-style mineralization.

Late Paleozoic arc volcanics and pericratonic sediments of the Lay Range Assemblage exposed between the northern Lay Range and Ingenika River, have closer lithologic and age similarities with the middle and upper part of the Dorsey Assemblage than with Yukon-Tanana rocks seen in the Finlayson Lake area of the Yukon.

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