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GEOLOGY AND MINERAL OCCURRENCES OF THE MOUNT TATLOW MAP AREA (92O/5, 6, and 12)

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INTRODUCTION

The Mount Tatlow map area is located about 240 kilometres north of Vancouver (Figure 1-3-1), along the eastern boundary of the Coast Mountains. Elevations in the rugged mountainous western part of the study area range from 1300 metres to just over 3000 metres. To the north and east the physiography changes abruptly to the flat, open range terrain of the Interior Plateau; elevations there vary from 1300 to 1800 metres.

This report introduces the Tatlayoko project, and discusses the observations of the first of three proposed field seasons. The project is partially funded by the Canada - British Columbia Mineral Development Agreement 1991-1995, and is designed to provide a modern database for evaluating mineral potential in this part of the Coast Mountains. The project area is contiguous with the recently mapped Taseko – Bridge River area to the southeast (Schiarizza *et al.*, 1990a and references therein; Schiarizza *et al.*, in preparation) and the Chilko Lake area to the southwest (McLaren, 1990; Figure 1-3-1).

REGIONAL GEOLOGIC SETTING

The Mount Tatlow map area lies along the northeastern edge of the eastern Coast Belt (Monger, 1986; Journeay, 1990), which includes a number of distinct, partially coeval lithotectonic assemblages that originated in ocean basin, volcanic arc and clastic basin environments. These units are late Paleozoic to Cretaceous in age and are intruded by granitic rocks of mid-Cretaceous through Early Tertiary age. They are juxtaposed across complex systems of contractional, strike-slip and extensional faults of mainly Cretaceous and Tertiary age. Lithotectonic units and structures of the eastern Coast Belt extend southward into the Cascade fold belt of Washington State (Misch, 1966), and comprise a strongly tectonized zone between the Intermontane Belt to the east and the western Coast Belt and Wrangellia to the west (Monger, 1990). Stratigraphic relationships between lithotectonic assemblages of the eastern Coast Belt and coeval rocks to the east and west are uncertain or disputed.

The Mount Tatlow area is underlain by upper Paleozoic through Lower Cretaceous rocks of the Bridge River Complex, Cadwallader Terrane, and the Tyaughton and Methow basins, together with Upper Cretaceous sedimentary and volcanic rocks of the Silverquick and Powell Creek formations. These rocks are intruded by Cretaceous and Tertiary dikes and stocks, and are overlain by Neogene plateau lavas of the Chilcotin Group. The most prominent structural feature of the area is the northwest-striking Yalakom fault, which was the locus of more than 100 kilometres of Eocene(?) dextral strike-slip displacement.

LITHOLOGIC UNITS

BRIDGE RIVER COMPLEX

The Bridge River Complex is best exposed in the Bridge River drainage basin, 100 kilometres southeast of Mount Tatlow. There it comprises an assemblage of chert, argillite, greenstone, gabbro, blueschist, limestone and clastic sedimentary rocks with no coherent internal stratigraphy (Potter, 1986; Schiarizza *et al.*, 1989, 1990a). Cherts range from Mississippian to late Middle Jurassic in age (Cordey, 1991), and blueschist-facies metamorphism occurred in the Triassic (Archibald *et al.*, 1991). In its type area, the Bridge River Complex is structurally interleaved with Cadwallader Terrane, and is stratigraphically overlain by Tyaughton basin sedimentary rocks.

The Bridge River Complex is represented in the Mount Tatlow area by several poorly exposed creek outcrops of sheared ribbon chert that define a thin east-west strip through the forested slopes northeast of Mount Tatlow. The grey and black chert beds are 1 to 6 centimetres thick, and separated by thinner interbeds of dark grey argillite. Chert beds are intensely fractured in all directions normal to bedding surfaces. Beds are commonly crumpled (Plate 1-3-1). Associated with the chert beds are chert-rich sandstones, amygdaloidal greenstones, intensely foliated blue-green serpentinite lenses, and sheared muddy breccias containing boulders of greenstone, chert and marble. Shear foliations in all of these rocks strike east and are subvertical.

The Bridge River Complex within the Mount Tatlow area apparently comprises a fault-bounded lens that separates Cadwallader Terrane to the north from the Taylor Creek Group to the south. It is commonly associated with these same units in its type area, more than 100 kilometres to the southeast. The fault-bounded panels north of Mount Tatlow are truncated to the east by the Yalakom fault.

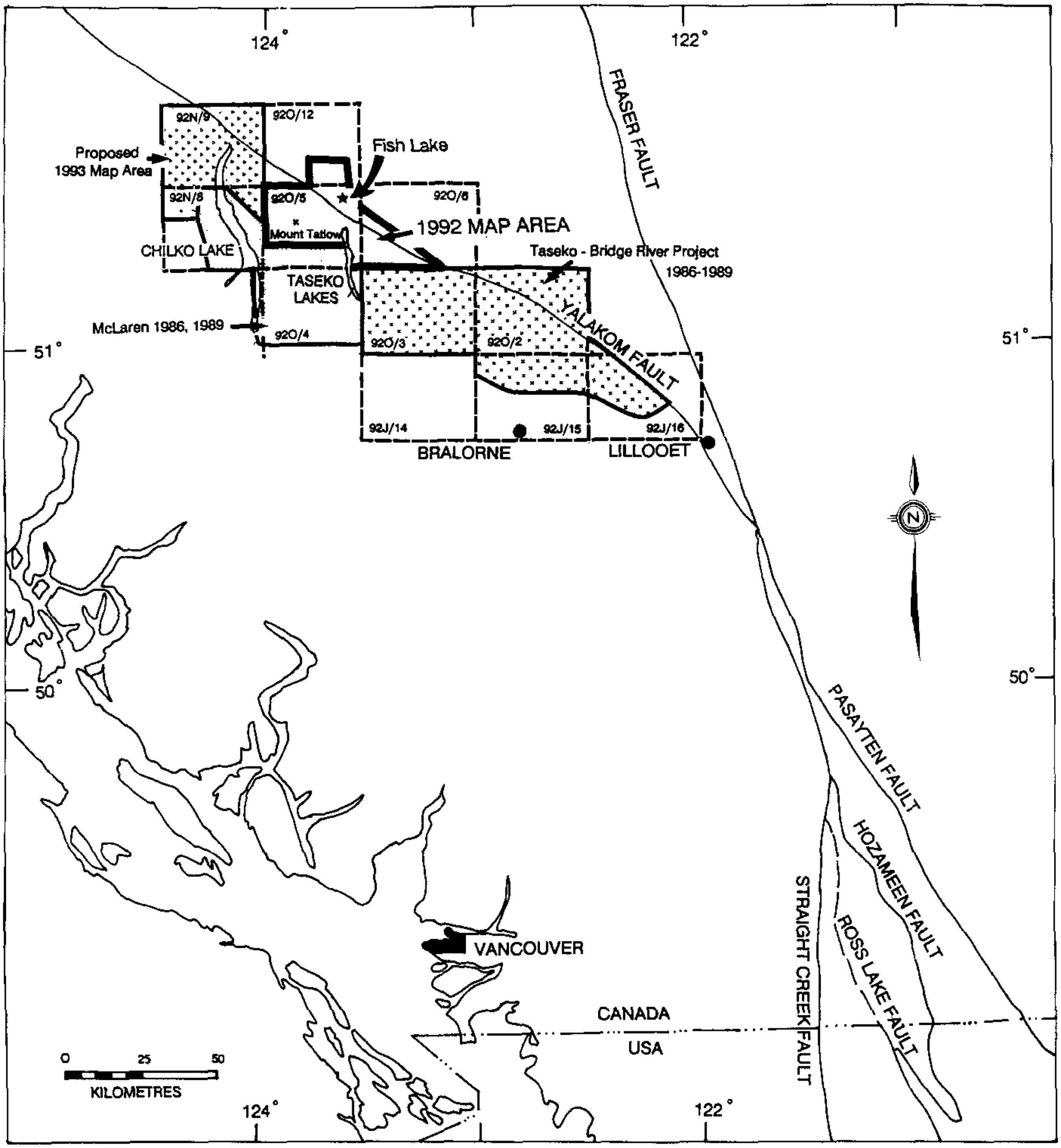

Figure 1-3-1. Location map.

Cadwallader Terrane

The Cadwallader Terrane, as defined 75 kilometres southeast of Mount Tatlow, consists of Upper Triassic volcanic and sedimentary rocks of the Cadwallader and Tyaughton groups, and Lower to Middle Jurassic clastic sedimentary rocks of the informally named Last Creek formation (Rusmore, 1987; Rusmore *et al.*, 1988; Umhoefer, 1990). Trace element geochemistry of volcanic rocks and the composition of the clastic sedimentary rocks suggests that the rocks of Cadwallader Terrane accumulated on or near a volcanic arc.

Rocks assigned to the Cadwallader Terrane in the Mount Tatlow area include siltstones, sandstones, conglomerates and limestones correlated with the Upper Triassic Hurley

Plate 1-3-1. Bridge River ribbon chert.

Formation (Cadwallader Group), together with overlying siltstones and cherty argillites correlated with the Lower to Middle Jurassic Last Creek formation.

HURLEY FORMATION

Rocks assigned to the Upper Triassic Hurley Formation (uTRCH) are exposed in an east-striking band about 12 kilometres long and 2 kilometres wide, north of Mount Tatlow. They crop out in the lowest set of bluffs south of Konni Lake and in canyons in Tsoloss and Elkin creeks near their confluence. Disrupted Hurley-type rock sequences (uTRCHy) and associated sheared serpentinite lenses crop out along the trace of the Yalakom fault east of Big Onion Lake and in Elkin Creek downstream from the confluence with Tsoloss Creek.

The Hurley Formation in the Mount Tatlow area consists mainly of thinly bedded black-and-tan siltstones and shales with thin to medium interbeds of brown-weathering calcareous argillite, siltstone, sandstone and argillaceous limestone. These predominantly thin-bedded intervals are punctuated by thick, commonly graded beds of calcareous sandstone, and locally by limestone-bearing pebble to cobble conglomerates. The conglomerates have limy sand or mud matrix and also contain clasts of granitoid and volcanic rock, chert and calcarenite. Small carbonaceous fragments of plant debris were found in brown calcarenites in Tsoloss Creek and Elkin Creek outcrops. The Hurley Formation also includes massive, white-weathering limestone, which forms a lens several tens of metres thick within clastic rocks on the low slopes southeast of Konni Lake.

The belt of rocks we assign to the Hurley Formation was in large part mapped as Lower Cretaceous Taylor Creek Group by Tipper (1978), although he included the exposures of massive white limestone southeast of Konni Lake in the Upper Triassic Tyaughton Group. We have previously mapped the Hurley Formation from its type area near Eldorado Creek (Rusmore, 1985, 1987) eastward to the Yalakom River (Schiarizza *et al.*, 1989, 1990a), and are confident that the belt north of Mount Tatlow is part of the formation. Collections of limestone and calcareous argillite are presently being processed for conodonts in an attempt to confirm the inferred Late Triassic age of the rocks.

LAST CREEK FORMATION

The Hurley Formation is stratigraphically overlain to the south by an east-striking belt of rocks that we assign to the Last Creek formation. Our assignment is consistent with that of Tipper (1978) who mapped these rocks as the Lower to Middle Jurassic portion of the Tyaughton Group (equivalent to the Last Creek formation in the revised nomenclature of Umhoefer, 1990). The formation is exposed in the Tsoloss Creek canyon and northeast of Tatlow Creek, where it consists mainly of well-bedded grey to black cherty argillite. Pyrite is abundant in some beds, and they weather rusty orange where sheared. The sequence also includes black micritic limestone beds 2 to 10 centimetres thick and minor cobble conglomerate with limy matrix and sedimentary and volcanic clasts. West of Tatlow Creek we mapped a discontinuous coquina bed 5 metres thick, and collected belemnites, radiolarians, shell fragments and ribbed bivalves from another limestone bed.

In its type area near Tyaughton Creek, the Last Creek formation comprises upper Hettangian to middle Bajocian conglomerate, sandstone and shale that disconformably overlies the Upper Triassic (middle to upper Norian) Tyaughton Group (Umhoefer, 1990). Correlative rocks have also been identified farther east, in the Camelsfoot Range, where they comprise cherty argillites and argillaceous limestones that overlie the Hurley Formation. These rocks were included in the Hurley Formation in the preliminary map and report by Schiarizza *et al.*, 1990a), but have subsequently yielded two collections of radiolaria of Early or Middle Jurassic and Middle Jurassic age, respectively. The Last Creek formation north of Mount Tatlow is specifically correlated with the Last Creek formation of the Camelsfoot Range, which it closely resembles in lithology and in its stratigraphic position directly above the Hurley Formation.

TYAUGHTON BASIN

The Tyaughton basin (Jeletzky and Tipper, 1968; Garver, 1992) includes shallow-marine clastic sedimentary rocks of the Middle Jurassic to Lower Cretaceous Relay Mountain Group, together with synorogenic marine clastic rocks of the Lower Cretaceous (Albian) Taylor Creek Group. Within the Mount Tatlow area, the Tyaughton basin is represented only by the Taylor Creek Group.

TAYLOR CREEK GROUP

The Taylor Creek Group outcrops as an east-trending belt north of the Mount Tatlow ridge system, where it is in fault contact with the Last Creek formation and Bridge River Complex to the north, and the Powell Creek and Silverquick formations to the south. It also underlies much of the southeastern part of the map area, in a belt that extends from Taseko Lake to Nadila Creek. Taylor Creek Group exposures in this area are cut by numerous intrusions, and unconformably overlain by Powell Creek volcanics and Quaternary cover.

The Taylor Creek Group consists largely of black shale and siltstone, together with chert-rich sandstone and pebble conglomerate. Olive-green muscovite-bearing sandstones, brown limy sandstone, and green ash and crystal tuffs also occur in the Taylor Creek sequence.

Pebble conglomerate is the most distinctive lithology. It contains clasts of white, grey, green, black and red chert, together with white and grey quartz, felsic volcanic rocks and, more rarely, calcarenite, black shale and siliceous argillite. Most of the conglomerates are clast supported, but sandy matrix-supported beds also occur. Pebbles are commonly 1 to 2 centimetres across, and rarely larger than 4 centimetres.

Black shale beds are commonly splintered and locally contain lighter coloured silty and sandy interbeds, resistant carbonate-cemented interlayers, thin micrite beds, and limestone concretions. Small plant fragments and cone fragments are rare. Shales are commonly cleaved into paper-thin sheets near intrusions.

The Taylor Creek Group in the southeastern part of the Mount Tatlow map area is lithologically similar to, and in part continuous with, the Taylor Creek Group in the northwestern corner of the Warner Pass map area (Glover and Schiarizza, 1987). Those rocks were also mapped as Taylor Creek Group by Tipper (1978), but he assigned rocks we include in the group along Taseko Lake and north of Mount Tatlow to the sedimentary unit of the Kingsvale Group. McLaren and Rouse (1989) adopted the revised nomenclature of Glover *et al.* (1988a, b) and reassigned the sedimentary rocks along Taseko Lake to the Silverquick formation, which locally rests gradationally beneath the Powell Creek (Kingsvale Group) volcanics to the southeast. None of the rocks we include in the Taylor Creek Group are dated, but we did not note any lithologic distinction that warrants separation into two different units. Furthermore, our mapping along Taseko Lake west of Taseko Mountain reveals that the sedimentary rocks there lie beneath the Powell Creek formation across an angular unconformity; this corroborates their correlation with the Taylor Creek Group to the southeast, which is also unconformably overlain by the Powell Creek formation (Glover and Schiarizza, 1987).

SILVERQUICK FORMATION

The name "Silverquick" was introduced by Glover *et al.* (1988a, b) and Garver (1989) as an informal name for a thick succession of middle to Upper Cretaceous, predominantly nonmarine clastic sedimentary rocks that are well exposed in the Noaxe Creek and Bralorne map areas. There, the Silverquick formation consists of a lower unit of chert-rich conglomerates and associated finer grained clastic rocks, and an upper unit of predominantly volcanic-clast conglomerates; this succession rests unconformably on the Taylor Creek Group and grades upwards into andesitic breccias of the Powell Creek formation. The Silverquick formation is absent in the northwestern part of the Warner Pass map area and the contiguous part of the Mount Tatlow map area east of Taseko Lake, where the Powell Creek formation rests directly on the Taylor Creek Group. A succession of volcanic conglomerates and breccias at the base of the Powell Creek formation in the western part of the Mount Tatlow map area is, however, tentatively included in the formation, as it closely resembles the upper, volcanic-rich portion of the Silverquick formation in its type locality.

The Silverquick formation crops out in a westward-thickening wedge northwest of Mount Tatlow, where its pronounced stratification readily distinguishes it from the more massive and resistant flow breccias of the overlying Powell Creek formation (Plate 1-3-2). It consists mainly of volcanic conglomerates and breccias in beds ranging from tens of centimetres to more than 10 metres thick. Andesitic clasts are poorly sorted, angular to subrounded and generally vary in size from less than a centimetre to 30 centimetres; coarse conglomerates in the lower part of the unit, however, contain clasts more than 1 metre in size. The matrix is commonly sandy and rich in feldspar and

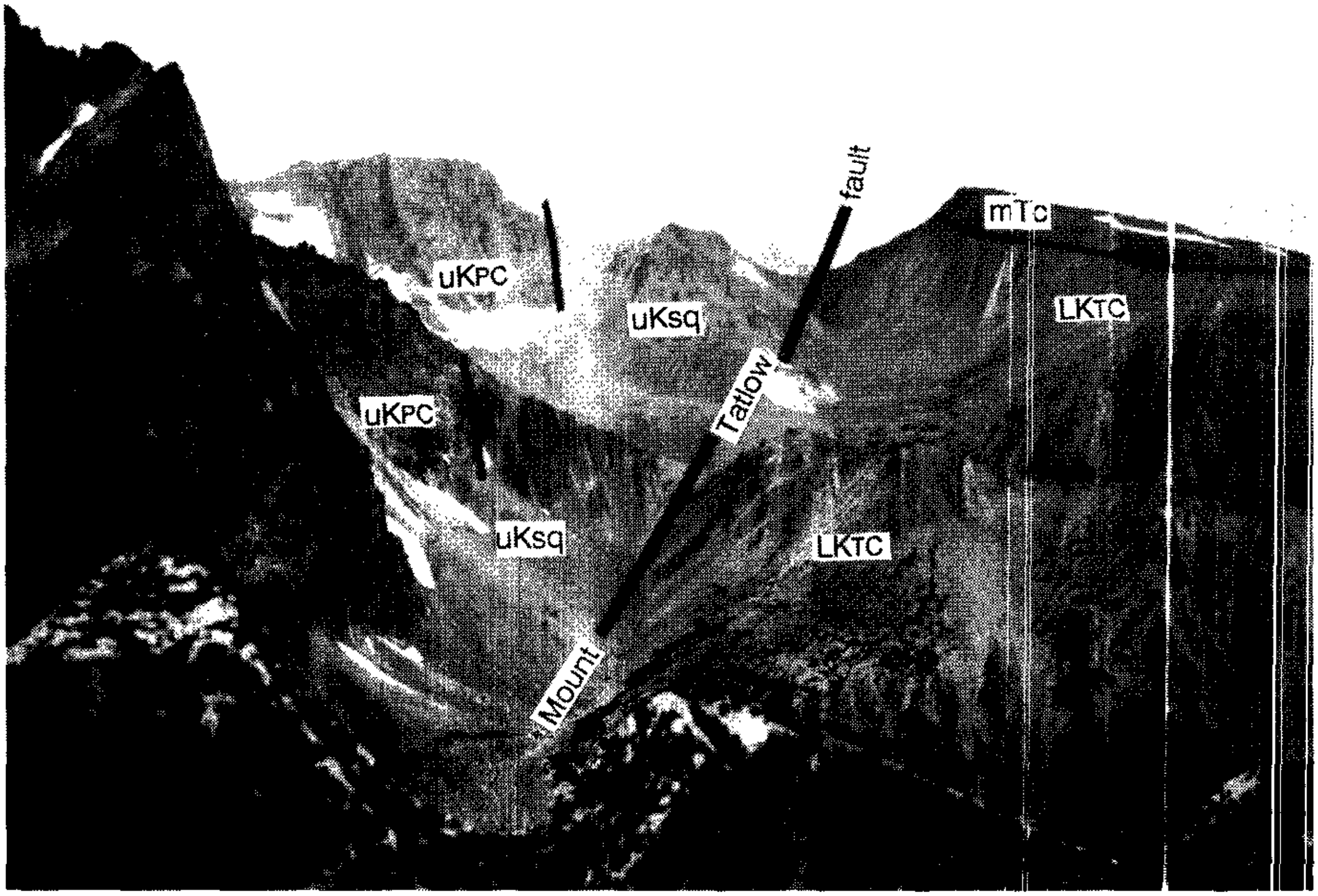

Plate 1-3-2. View to the west from the slope north of Mount Tatlow peak.

hornblende crystals. Stratification is accented by relatively thin interlayers of purplish siltstone. The base of the Silverquick formation is not seen as it is bounded to the north by the east-striking Mount Tatlow fault. The east-tapering outcrop geometry of the unit in part reflects truncation along this fault, but a primary depositional pinch-out is also inferred as this unit does not occur farther east, where massive breccias of the Powell Creek formation rest directly on the Taylor Creek Group.

Powell Creek Formation

The Powell Creek formation (informal) is a thick succession of Upper Cretaceous volcanic and volcaniclastic rocks. These rocks were assigned to the Kingsvale Group by Jeletzky and Tipper (1968) and Tipper (1978). The name "Powell Creek" was introduced by Glover *et al.* (1988a, b) following the work of Thorkelson (1985), who suggested that the term "Kingsvale Group" be abandoned as it is not a valid stratigraphic entity where originally defined by Rice (1947), and has not been used consistently by subsequent workers.

The Powell Creek formation underlies the steep peaks of Mount Tatlow and the adjacent mountains and ridges, and also outcrops in the hills east of Lower Taseko Lake and on ridges east and south of Anvil Mountain. It comprises more than 2000 metres of andesitic flow breccias, crystal and ash tuffs, laharic breccias, flows, and volcaniclastic sandstones and conglomerates. Feldspar and hornblende-needle dikes and sills are common within the succession and may be coeval with the volcanics. Fragmental facies are far more abundant than flows. The sequence is notable for its compositional uniformity; fragmental materials in the breccias and tuffs do not represent any sources outside the unit itself.

Fragmental rocks are purple and green or green on fresh surfaces, and are rich in plagioclase crystals and crystal fragments. Many are rich in hornblende and some contain pyroxene. High hematite content is responsible for the purple colours which range from pale lilac and mauve to scarlet and maroon.

Flow breccias are massive, and the most resistant rocks in the sequence; they support the high peaks and form the steep cliffs. Clasts are normally 1 to 8 centimetres across; breccias with larger clasts occur locally. Epidote alteration is pervasive in the flow breccias on fracture planes and as clots.

Laharic breccias are a significant part of the section on the ridges south of Mount Tatlow peak (Plate 1-3-3). The lahars have a muddy matrix and are unsorted, with rounded cobbles and boulders of all sizes up to over a metre across. Muddy and sandy layers, centimetres to tens of metres thick, are intercalated with the coarse beds and delineate the bedding. On a gross scale, the bedded intervals are remarka-

Plate 1-3-3. Laharic breccias with muddy interbeds of Unit uKpc, south of Mount Tatlow peak.

bly planar; individual layers can be traced without disruption for thousands of metres. Muddy layers weather brown and maroon, and are brick-red in some sections.

Ash and crystal tuffs typically form relatively thin sections (<10 m) within sequences dominated by flow breccias or lahars. An exception to this is at the Vick property on the mountain directly west of the narrows at the foot of Lower Taseko Lake. There, the top 300 or 400 metres of section on the mountaintop are dominated by crystal tuffs, with lesser intercalated flow breccia. The tuffs are markedly less resistant than other rock types in the Powell Creek formation and the transition to tuffs from flow breccia is marked by an abrupt break in slope. Tuff matrix is commonly calcareous and in some places the rock is friable. The tuffs have a grainy or sugary appearance on weathered surfaces.

Most flows are andesitic, but dacites also occur, and thin bands of rhyolite are intercalated in the section at the Vick property. The andesite flows are green, and feldspar-hornblende or feldspar-pyroxene phyric. In the coarsest flows crowded feldspar crystals are up to 5 millimetres across.

The Powell Creek formation lies conformably above the Silverquick formation northeast of Mount Tatlow, but rests unconformably above the Taylor Creek Group east of Taseko Lake and in the contiguous part of the Warner Pass map area to the south (Plate 3-4-2 of Glover and Schiarizza, 1987). The age of the Silverquick and Powell Creek formations is constrained only by plant fossils, most of which indicate a general Albian to Cenomanian age (Jeletzky and Tipper, 1968; Schiarizza *et al.*, in preparation). As the unconformably underlying Taylor Creek Group includes middle and upper(?) Albian rocks (Garver, 1989), the Powell Creek formation is thought to be largely Cenomanian.

Methow Basin

The Methow basin includes Lower Jurassic to mid-Cretaceous rocks that crop out east of the Fraser fault in the Methow Valley of northern Washington State and contiguous southwestern British Columbia (McGroder *et al.*, 1990). Correlative rocks (mainly Lower Cretaceous Jackass Mountain Group) also crop out west of the Fraser fault, and extend from the Camelsfoot Range northwestward to the Mount Tatlow area. These exposures of the Jackass Mountain Group were included in the Tyaughton basin by Jeletzky and Tipper (1968) and Kleinspehn (1985), who considered the Methow and Tyaughton as parts of the same basin, fragmented by the Yalakom and Fraser fault systems. Thus the Tyaughton and Methow subdivisions have commonly come to reflect the present geographic distribution of rocks inferred to have been deposited in a once-continuous basin, referred to as the Tyaughton-Methow basin (Kleinspehn, 1985).

We adopt a different approach and define the Tyaughton and Methow basins strictly in terms of their distinctive stratigraphies. Within the Taseko - Bridge River and Mount Tatlow map areas the Tyaughton basin comprises the uppermost Middle Jurassic to Lower Cretaceous Relay Mountain Group together with the Lower Cretaceous Taylor Creek Group. The Methow basin includes Middle Jurassic rocks correlated with the Ladner Group together with overlying Lower Cretaceous rocks of the Jackass Mountain Group (Schiarizza *et al.*, 1990a). The two assemblages are locally in contact across Cretaceous and Tertiary faults. Provenance studies indicate that the two basins received detritus from common source terrains in the mid-Cretaceous (Garver, 1992), but they had little in common prior to that time.

In the Taseko - Bridge River map area, Methow basin strata occur as two distinct facies, referred to as the Yalakom Mountain and Churn Creek facies respectively (Schiarizza *et al.*, in preparation). The lower part of the Yalakom Mountain facies consists of Middle Jurassic volcanic sandstones and rare volcanic breccias that Schiarizza *et al.* (1990a) correlate with the Dewdney Creek Formation of the Ladner Group (O'Brien, 1986, 1987). These Middle Jurassic rocks are disconformably(?) overlain by a lithologically similar succession that has yielded Barremian and Aptian fossils and is assigned to the lower part of the Jackass Mountain Group (this unit includes Unit 7b of Roddick and Hutchison, 1973, and Unit 3v of Glover *et al.*(1988a), but was included in the upper part of the Jurassic volcanic sandstone unit of Schiarizza *et al.*, 1990a). The Barremian-Aptian unit is in turn overlain by a distinct assemblage of arkosic sandstones and granitoid-bearing pebble conglomerates of Albian age [includes units 7c and 7d of Roddick and Hutchison (1973), Unit 3ak of Glover *et al.* (1988a), and the Jackass Mountain Group of Schiarizza *et al.* (1990a)].

The Churn Creek facies includes an interval of poorly exposed Middle Jurassic sandstones and siltstones that are overlain by two mappable units of the Jackass Mountain Group. The lower part of the group comprises volcanic sandstones rich in plant debris (Unit 3f of Glover *et al.*, 1988a) that have yielded plant fossils of probable Aptian age (Jeletzky and Tipper, 1968). The upper unit of the Jackass Mountain Group consists mainly of granitoid-bearing cobble and boulder conglomerates (Unit 3cg of Glover *et al.*, 1988a). This unit is not dated, but is correlated with the Albian arkose unit of the Yalakom Mountain facies.

Both the Churn Creek and Yalakom Mountain facies of the Methow basin are represented in the Mount Tatlow map area. The Churn Creek facies is exposed northeast of the Yalakom fault, where it was mapped as the Kingsvale Group sedimentary unit by Tipper (1978). The Yalakom Mountain facies outcrops southwest of the Yalakom fault on the slopes north of Konni Lake. Our mapping supports the interpretation of Kleinspehn (1985) that these exposures were displaced from the Camelsfoot Range by more than 100 kilometres of dextral movement along the Yalakom fault (*see* section on Structural Geology).

YALAKOM MOUNTAIN FACIES

The Yalakom Mountain facies is well exposed on the south-facing slopes of Konni Mountain and Mount Nemaiah, north of Konni Lake. The section dips steeply to the north and is right side up. It comprises two mappable units that correlate with the two units of the Yalakom Mountain facies mapped in the southwestern Camelsfoot Range (Schiarizza *et al.*, 1990a).

The lower unit (JKy) outcrops on the slopes directly north of Konni and Nemaia lakes. It consists mainly of green to grey gritty sandstones and granule to small-pebble conglomerates which occur as medium to thick beds intercalated with lesser volumes of finer grained sandstone, siltstone and shale. The sandstones and conglomerates are well indurated, and contain feldspar, volcanic lithic fragments, some quartz and abundant shale rip-up clasts. The unit also includes a thin band (<10 m) of blue-green andesitic lapilli tuff and breccia. Tipper (1969) reports a probable lower Bajocian ammonite from near the northeast end of Konni Lake, so Unit JKy is at least in part Middle Jurassic. The correlative unit in the Camelsfoot Range contains Aalenian and Bajocian ammonites (Schiarizza *et al.*, 1990a; Mahoney, 1992) but passes stratigraphically upward into lithologically similar rocks that have yielded Early Cretaceous (Barremian and Aptian) fossils (in part Unit 7b of Roddick and Hutchison, 1973).

The upper unit of the Yalakom Mountain facies (Unit lKJMy) consists mainly of olive-green to blue-green feldspathic-lithic sandstones and gritty sandstones. The sandstones form massive resistant layers, tens of metres to more than 100 metres thick, that are intercalated with substantial intervals of grey siltstone and shale. Massive sandstone at the base of the unit forms the lowest set of prominent cliffs on the south flank of Konni Mountain. The contact was actually observed at only one locality, where it is marked by several metres of granitoid-bearing pebble to cobble conglomerate. A similar thin conglomerate interval marks the base of the correlative interval in the Camelsfoot Range (Jackass Mountain Group of Schiarizza *et al.*, 1990a). There, the unit locally contains fossils of Albian age (includes Units 7c and 7d of Roddick and Hutchison, 1973).

Tipper (1978) included the Jurassic rocks north and south of Konni Lake in the same unit, which he mapped as the Jurassic section of the Tyaughton Group (Last Creek formation in present terminology). However, the Jurassic rocks north of the lake, here assigned to the Methow basin, are lithologically distinct from the Middle Jurassic portion of the Last Creek formation, which consists of black calcareous shale or cherty argillite with only minor amounts of coarser grained clastic rocks (Umhoefer, 1990; Last Creek formation of this report). The Jurassic rocks of Unit JKy are lithologically more similar to the Middle Jurassic volcanic sandstones, conglomerates, tuffs and flows that comprise the Dewdney Creek Formation of the Ladner Group (O'Brien, 1986, 1987), with which they are here correlated.

CHURN CREEK FACIES

Rocks of the Churn Creek facies are restricted to the northeast side of the Yalakom fault. They crop out on the

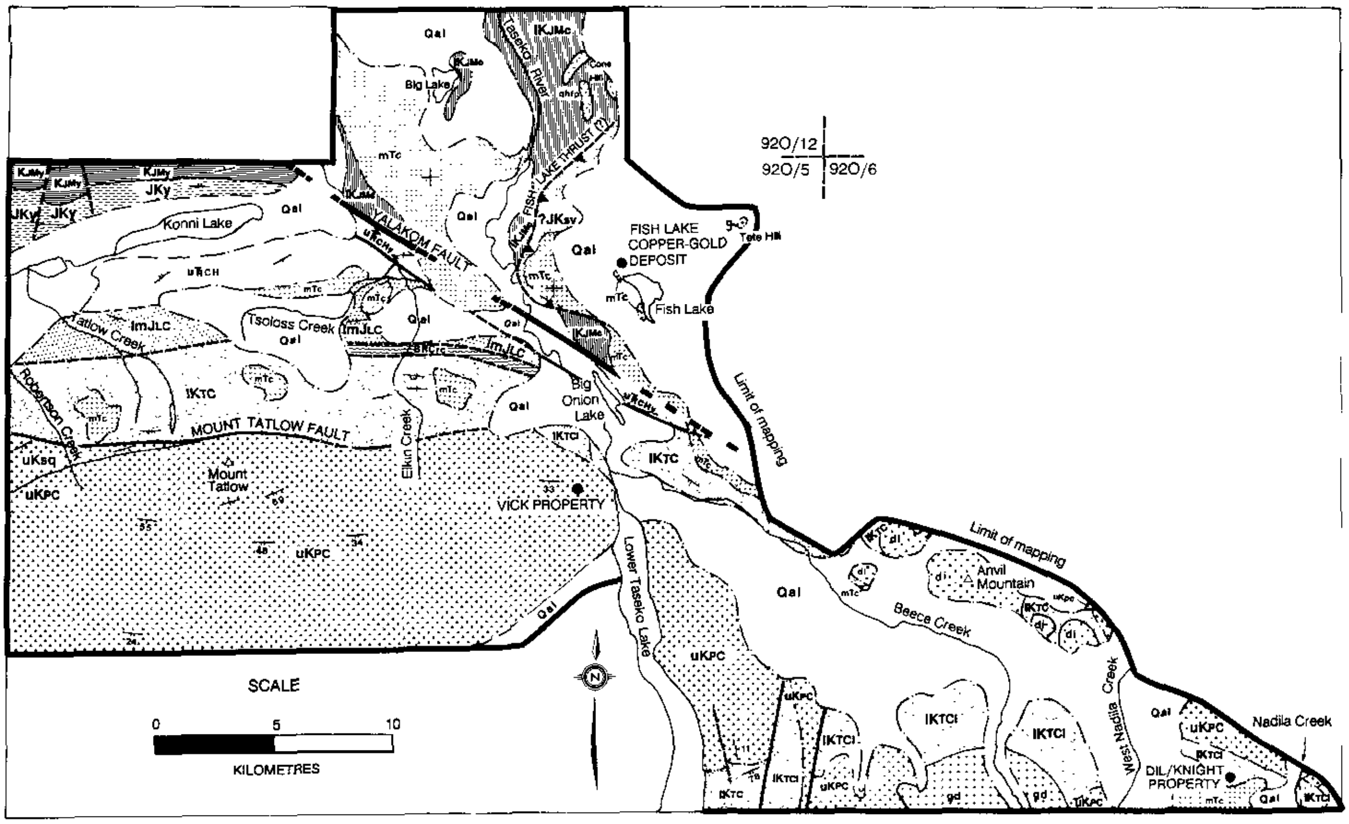

Figure 1-3-2. Generalized geology of the Mount Tatlow map area.

steep slopes on both sides of the Taseko River, in the Elkin Creek canyon, and in creek gullies east of the Taseko River below the level of the Chilcotin Group basalts (about 1600 m). Both the plant-rich volcanic sandstone unit and the overlying granitoid-bearing conglomerate unit of the Jackass Mountain Group are represented in these exposures. However the stratigraphic contact between them is difficult to follow due to poor exposure and numerous small faults. Consequently both units are included within one designation (lKJMc) on the geological map (Figure 1-3-2).

The lower unit is dominated by green, coarse-grained feldspathic sandstone with abundant carbonized logs, branches and twigs. Weathered surfaces are green, grey or brown. Sandstone grains include plagioclase crystals and felsic, intermediate and mafic volcanic lithic fragments. Quartz is present in most of the sandstones and in some locations is abundant. Black, angular rip-up clasts occur locally. The sandstones are thick to medium bedded, but are commonly massive with bedding that is conspicuous only from a distance; locally they are crossbedded. Granule to cobble conglomerates with a sandy matrix are also common within the unit. Clast/matrix ratios range from about 80/20 to 50/50. Conglomerate clasts include andesitic feldspar-crystal lithic tuff, quartzite, quartz-feldspar sandstone, silicified volcanic rock, hornblende and feldspar-phyric andesite, and rare, medium grey chert. Black shale beds also occur in the section, but they outcrop poorly.

Marine fossils were found in the lower unit of the Churn Creek facies east of Big Lake and in the Elkin Creek canyon. The fossil assemblage includes shell fragments, gastropods, ribbed and smooth-shelled bivalves, and, at the Elkin Creek location, a large ammonite.

The upper conglomerate unit of the Churn Creek facies is well exposed in the bluffs along the east side of the Taseko River in the northernmost section of the map area. The conglomerates are poorly sorted with a sandy matrix. Well-rounded clasts of medium-grained granodiorite and dark to medium green feldspar-phyric volcanic rocks up to 60 centimetres across are most abundant. Feldspar-crystal tuff, dark grey massive basalt and green chert clasts were also observed. Granodiorite boulders are generally larger than other types. No plant or animal fossils were found in this unit.

Volcanic and Sedimentary Rocks Near Fish Lake Creek

An enigmatic assemblage of volcanic and sedimentary rocks crops out south and east of the Churn Creek facies near the mouth of the creek that drains Fish Lake. It is designated Unit JKsv on Figure 1-3-2. This assemblage includes andesite with minor rhyolite layers, tuffaceous sandstone, pebbly sandstone with carbonaceous plant remains and limestone rip-ups, black argillite with shell fragments, and well-bedded flinty siltstone.

We speculate that these rocks are related to the volcanic and sedimentary package (observed only in drill core) that hosts the Fish Lake porphyry copper-gold deposit. The Fish

LEGEND

QUATERNARY

Qal — *unconsolidated glacial, fluvial and alluvial deposits*

MIOCENE TO PLIOCENE

CHILCOTIN GROUP

mTc — *olivine basalt flows, debris flows*

UPPER CRETACEOUS

POWELL CREEK FORMATION

uKpc — *purple and green andesitic flow breccia, crystal and ash tuffs, laharic breccias, flows, and volcanic sandstone*

SILVERQUICK FORMATION

uKsq — *well stratified volcanic conglomerate and breccia*

TYAUGHTON BASIN

LOWER CRETACEOUS

TAYLOR CREEK GROUP

lKTC — *chert pebble rich conglomerate black shale, siltstone, sandstone*

lKTCi — *Taylor Creek Group sedimentary rocks intruded by numerous hornblende feldspar porphyry dikes and stocks*

BRIDGE RIVER COMPLEX

MISSISSIPPIAN TO LATE MIDDLE JURASSIC

BRCr — *sheared ribbon chert, chert-rich sandstone, amygdaloidal greenstone, sheared muddy breccia containing boulders of greenstone, chert and marble*

CADWALLADER TERRANE

LOWER TO MIDDLE JURASSIC

LAST CREEK FORMATION

lmJLC — *well-bedded grey to black cherty argillite, thin fossiliferous micritic limestone beds, minor polymict cobble conglomerate with limy matrix*

UPPER TRIASSIC

HURLEY FORMATION

uTrCH — *thinly bedded calcareous brown-weathering sandstone, black-and-tan siltstone and shale, sandstone with limestone interbeds limestone-bearing polymict conglomerate*

YALAKOM FAULT ZONE

uTrCHy — *intensely deformed fragments of Hurley Formation strata, serpentinite lenses*

METHOW BASIN

YALAKOM MOUNTAIN FACIES

ALBIAN (?)

lKJMy — *feldspathic lithic sandstone and gritty sandstone, grey siltstone shale, granitoid-bearing pebble to cobble conglomerate*

MIDDLE JURASSIC AND (?)YOUNGER

JKy — *gritty feldspathic sandstone granule and pebble conglomerate siltstone, shale, minor blue-green andesitic breccia and tuff*

CHURN CREEK FACIES

LOWER CRETACEOUS (?)

lKJMc — *green feldspathic sandstone with abundant carbonized plant remains, overlain by polymict boulder and cobble conglomerate with volcanic and plutonic clasts*

ROCKS NEAR FISH LAKE CREEK

JURASSIC OR CRETACEOUS?

JKsv — *andesite, tuffaceous sandstone, minor rhyolite, phyllite, pebbly sandstone with plant remains and limestone rip-up clasts, black argillite, well-bedded limy sandstone*

INTRUSIVE ROCKS

MIDDLE EOCENE

BEECE CREEK PLUTON

gd — *light coloured medium-grained granodiorite to quartz monzonite*

CRETACEOUS TO TERTIARY

di — *hornblende diorite, leucodiorite and hornblende feldspar porphyry*

qhfp — *Cone Hill/Fish Lake suite, hornblende feldspar porphyry with quartz*

g — *Tete Hill granite*

Lake host package forms the hangingwall of a gently southeast-dipping fault (the Fish Lake thrust of Caira and Piroshco, 1992) that is intersected at about 750 metres depth in drill holes on the Fish Lake property. As sedimentary rocks that may correlate with the Churn Creek facies occupy the footwall, this same fault may constitute the boundary between Unit JKsv and exposures of Churn Creek facies to the west.

CHILCOTIN GROUP

Flat-lying basalt flows of the Chilcotin Group (Tipper, 1978; Bevier, 1983) crop out extensively in the map area. They unconformably overlie all older rock units and structures, including the Yalakom fault. They are part of the southwestern margin of an extensive belt of Early Miocene to early Pleistocene plateau lavas that covers 25 000 square kilometres of the Interior Plateau of south-central British Columbia (Mathews, 1989). The Chilcotin Group forms a blanket 50 to 200 metres thick that is preserved over much of northeastern part of Mount Tatlow map area, except in creek and river valleys that have cut down into the underlying rocks. Where the topographic relief is higher, Chilcotin Group flows form isolated erosional remnants that cap older rocks (Figure 1-3-2 and Plate 1-3-2).

The most common rock type is orange-brown weathered, black to dark grey basalt, locally with olivine and plagioclase phenocrysts. Flow thicknesses range from about 10 centimetres to 10 or 15 metres. Columnar jointing at the bases of flows is common and well developed, and flow tops are normally vesicular. In almost all locations, layering is near horizontal, the rocks are undeformed and the minerals are unaltered.

Spectacular debris flows are exposed beneath columnar-jointed flows in the cliffs east of the Taseko River, south of the Fish Lake turnoff. They are unsorted and unstratified and contain clasts up to 50 centimetres across. Clasts include Chilcotin-type rocks (amygdaloidal basalt, black glassy shards and dense black basalt with glassy rims) and foreign rocks (feldspar-porphyritic andesite, feldspathic sandstone and limestone). Beds of spherulitic ash tuff, lapilli tuff, and pahoehoe and aa lavas are also exposed in the cliffs.

INTRUSIVE ROCKS

DIORITE AND HORNBLENDE FELDSPAR PORPHYRY

Hornblende diorite, leucodiorite, and hornblende feldspar porphyry occur as stocks, plugs and dikes that intrude the Taylor Creek Group (Plate 1-3-4). They are most common along the Anvil Mountain ridge system and along the southern boundary of the map area east of Taseko Lake. However, they are represented in all areas where Taylor Creek Group rocks are exposed, including the north slopes of Mount Tatlow, near the headwaters of Elkin Creek. and along the Beece Creek road east of the foot of Lower Taseko Lake. These bodies were assigned tentative Eocene ages by Tipper (1978), but none are dated. Their abundance in the Taylor Creek Group and apparent absence in the Powell Creek formation suggests that at least some of the intrusive activity was mid-Cretaceous in age and predated deposition of the Powell Creek formation

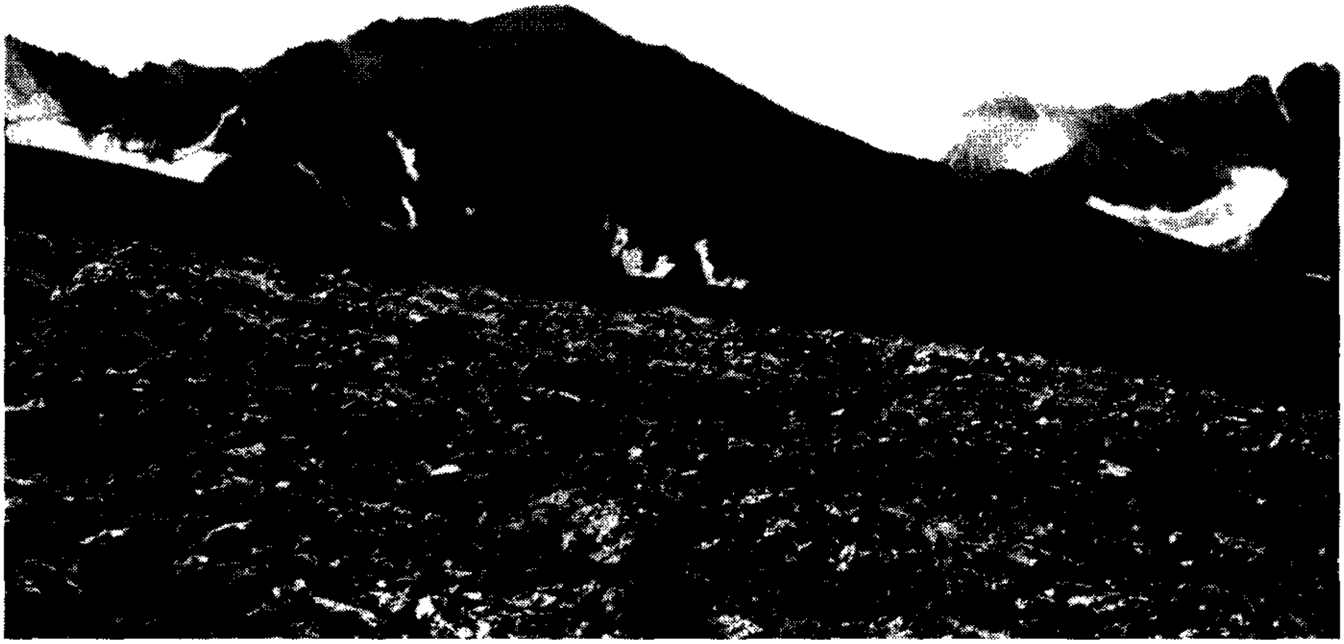

Plate 1-3-4. Light-coloured feldspar-porphyry dikes cut sedimentary rocks of the Taylor Creek Group, southern boundary of the map area, east of Taseko Lake.

QUARTZ FELDSPAR PORPHYRY

Light grey felsic sills and dikes occur within all Mesozoic rock units but do not constitute mappable bodies. These rocks contain equant euhedral white plagioclase up to 1 centimetre across, slightly smaller pinkish quartz grains, and 1 to 3-millimetre mafic grains in a pale grey groundmass. Felsic sills are particularly prominent within the Powell Creek formation on the ridges south of Mount Tatlow peak, where they are up to 120 metres thick and can be traced through adjacent ridges for several kilometres.

BEECE CREEK PLUTON

The Beece Creek pluton consists of light-coloured medium-grained quartz monzonite to granodiorite of Middle Eocene age (44 Ma, Archibald *et al.*, 1989). It crops out on the ridges east and west of Beece Creek near its headwaters, and extends south into the Warner Pass map area (Glover and Schiarizza, 1987). The pluton intrudes rocks of the Taylor Creek Group and the Powell Creek formation; abundant quartz porphyry and rhyolite dikes intrude country rocks adjacent to the pluton.

FISH LAKE - CONE HILL INTRUSIVE SUITE

A number of small stocks and dikes intrude both the Jackass Mountain Group and Unit JKsv in the vicinity of Cone Hill and Fish Lake Creek. Most are hornblende feldspar porphyries with varying amounts of quartz phenocrysts in a grey aphanitic felsic groundmass. There are differences in composition and texture between the bodies, but none are dated so it is not possible to say whether they are related to the same intrusive system. They resemble Fish Lake intrusive rocks in that they are feldspar porphyritic, often coarsely (>5 mm), and they generally contain quartz.

TÊTE HILL GRANITE

Tête Hill forms a solitary knob of hypabyssal granite that pokes up above the level of the Quaternary glacial deposits about 5 kilometres northeast of the Fish Lake deposit. The granite is fine grained; quartz, orthoclase and plagioclase crystals are less than 2 millimetres long. Some of the outcrops contain abundant miarolitic cavities. The miarolitic rocks are slightly coarser and contain plagioclase laths over 1 centimetre long that overprint the original rock texture. The age of the granite and its relationship with the Fish Lake intrusions are unknown.

STRUCTURE

STRUCTURE EAST OF TASEKO LAKE

The southeastern part of the Mount Tatlow map area is underlain mainly by the Taylor Creek Group and overlying Powell Creek formation. The contact is an angular unconformity that was observed 2 kilometres east of Taseko Lake, and is well exposed at several localities in the Warner Pass map area to the south (Glover and Schiarizza, 1987). The mid-Cretaceous deformation documented by this unconformity included southwest-vergent folding and thrusting that is well displayed in the Taseko - Bridge River area (Schiarizza *et al.*, 1990b).

The Taylor Creek Group in the Anvil Mountain - Nadila Creek area is overlain by the Powell Creek formation to the northeast and southwest, suggesting that it cores a broad northwest-trending anticline or arch. The abundant dioritic intrusions within the Taylor Creek Group in this area may be in part responsible for uplift along the axis of this structure; alternatively, the intrusions may predate the Powell Creek formation and the anticlinal fold. Other mappable structures in this area include a series of northerly striking faults along the southern boundary of the area east of Taseko Lake. These faults have apparent west-side-down displacement of the Powell Creek formation, but their actual sense of movement is unknown.

STRUCTURE OF THE KONNI LAKE – MOUNT TATLOW AREA

The structure southwest of the Yalakom fault and west of Lower Taseko Lake and Taseko River is dominated by four east-striking panels separated by east-striking faults. The northernmost panel comprises the Methow basin. It is separated from Cadwallader Terrane (Hurley and Last Creek formations) to the south by an inferred fault (the Konni Lake fault) in the valley of Konni and Nemaia lakes. The Cadwallader Terrane belt is also inferred to be bounded by a fault to the south, as it is at least locally separated from the Taylor Creek Group by a narrow lens of Bridge River rocks. The Taylor Creek Group is, in turn, faulted against the Powell Creek and Silverquick formations to the south; the trace of this fault is well defined in the vicinity of Mount Tatlow, where it is parallel to bedding in the Taylor Creek Group, but truncates the Silverquick/Powell Creek contact (Plate 1-3-2).

Methow basin rocks north of Konni Lake comprise a simple north-dipping homocline that, farther to the northwest, is folded through an east-northeast-trending, doubly plunging syncline (Tipper, 1969). The internal structure of the Powell Creek formation is also relatively simple, and comprises a broad east-trending syncline. The intervening Taylor Creek Group, Bridge River Complex and Cadwallader Terrane, however, are strongly deformed by east-plunging folds that are observed on the mesoscopic scale, and indicated on a larger scale by domains of opposing facing directions. Folds with both north and south vergence were mapped, but the macroscopic geometry of the belts is not well constrained. It is suspected, but not proven, that much of the internal deformation within these belts occurred during the mid-Cretaceous contractional deformation documented beneath the sub-Powell Creek unconformity to the southeast.

None of the inferred major east-striking faults between Konni Lake and Mount Tatlow was actually observed. The Mount Tatlow fault is Late Cretaceous or younger, while the two faults to the north are mid-Cretaceous or younger. A northerly dipping mesoscopic fault observed within the Taylor Creek Group along Elkin Creek has oblique reverse-sinistral movement, and a prominent north-dipping fault within the northernmost Silverquick exposure on the ridge west of Robertson Creek displays northeast-plunging slickensides compatible with a similar sense of movement. These observations are of interest because reverse-sinistral faults have been documented in several areas in the Taseko - Bridge River area, including the Camelsfoot Range where they bound and imbricate structural panels that are inferred to be the offset equivalents of those at Konni Lake (see section on the Yalakom fault). The reverse-sinistral faults in the Taseko - Bridge River area are mainly Late Cretaceous in age, and are interpreted as later products of the same protracted deformational event that produced mid-Cretaceous thrust faults and folds. The major east-striking faults between Konni Lake and Mount Tatlow may also be products of this Late Cretaceous deformation, but this is not proven. Alternatively, or in addition, some of the east-trending structures in this area, such as the east trending synclines in the Methow basin and the Powell Creek formation, may have formed during Eocene or older dextral movement along the Yalakom fault.

STRUCTURE NORTHEAST OF THE YALAKOM FAULT

The structure of the Mesozoic rocks northeast of the Yalakom fault is poorly understood because much of the area is covered by flood basalts and thick glacial deposits. However, both north and northeasterly striking faults have been recognized. Major structures outlined by diamond drilling at the Fish Lake deposit include the Carnamba fault, an east-striking subvertical fault that transects the southern part of the deposit, and a gently east-southeast-dipping fault that marks the base of the deposit. The latter fault places mineralized volcanic and intrusive rocks above unmineralized sedimentary rocks; it has been named the Fish Lake thrust by geologists working on the deposit, although the movement sense along it has not been established. The 10° to 25° dip of the fault suggests that it will intersect the surface 2 to 4.5 kilometres west of the deposit; thus it may constitute the boundary between exposures of Churn Creek facies along the Taseko River and Unit JKsv to the east, but this is speculative as this contact is not exposed.

THE YALAKOM FAULT

Leech (1953) first used the name Yalakom fault for a system of steeply dipping faults bounding the northeast margin of the Shulaps Ultramafic Complex along the Yalakom River. The fault system was traced northwestward through the Taseko Lakes and Mount Waddington map areas by Tipper (1969, 1978) who postulated that it was the locus of 80 to 190 kilometres of right-lateral displacement. It was traced southeastward through the northeastern corner of Pemberton map area by Roddick and Hutchison (1973), from where it extends into the western part of the Ashcroft map area (Duffell and McTaggart, 1952; Monger and McMillan, 1989). There, it is truncated by the more northerly trending Fraser fault system, along which it is separated by about 90 kilometres from its probable offset equivalent, the Hozameen fault, to the south (Monger, 1985).

Within the Mount Tatlow area the Yalakom fault is well defined, although not well exposed, along lower Elkin Creek and on the slopes north of Big Onion Lake; elsewhere its trace is hidden beneath Miocene or Quaternary cover. The fault juxtaposes the Churn Creek facies of the Jackass

Mountain Group to the northeast against a number of different map units to the southwest. Where defined, the fault zone comprises up to several hundred metres of fractured and sheared sedimentary rock, most of which resembles Hurley Formation, structurally interleaved with lenses of serpentinite. No reliable shear-sense indicators were observed within the fault zone.

On its southwest side, the Yalakom fault truncates a succession of east-striking fault panels that include, from north to south: the Yalakom Mountain facies of the Methow basin; Cadwallader Terrane; and the Bridge River Complex. The same three-part structural succession is truncated on the northeast side of the Yalakom fault in the Camelsfoot Range, more than 100 kilometres to the southeast, and provides an estimate of dextral offset along the fault. This correlation strengthens the argument of Kleinspehn (1985) who postulated about 150 kilometres of displacement by matching only a part of this structural succession, the Jackass Mountain Group of Methow basin.

Geological relationships in the southwestern Camelsfoot Range are summarized in Figure 1-3-3. In this area the Yalakom fault, which to the northwest is well defined as a single strand separating the Shulaps Ultramafic Complex from the Methow basin, bifurcates to enclose a lens of thrust-imbricated Cadwallader Terrane structurally overlying the Bridge River Complex. The lens is juxtaposed against the Shulaps Complex to the southwest by a fault along the Yalakom and Bridge rivers that was referred to as the Bridge River fault by Schiarizza *et al.* (1990a), and is interpreted to be the principal strand of the Yalakom fault by Schiarizza *et al.* (in preparation). Along the northeast boundary of the lens, Cadwallader Terrane is juxtaposed against the Yalakom Mountain facies of the Methow basin across a fault that was labelled Yalakom fault by Schiarizza *et al.* (1990a), but which Schiarizza *et al.* (in preparation) call the Camelsfoot fault, and interpret as an older structure that is truncated by the Yalakom fault. The Camelsfoot fault is not well exposed, but appears to dip northeast; it, together with northeast-dipping thrust and oblique (sinistral) thrust faults within structurally underlying Cadwallader Terrane and Bridge River Complex are thought to have formed during mid-Cretaceous contractional deformation that is well defined elsewhere in the area (Schiarizza *et al.*, 1990b). This interpretation is consistent with that of Miller (1988), who examined the structures in a relatively small area north of the confluence of the Bridge and Fraser rivers and concluded that they fit a strain ellipse for left-lateral slip along the Yalakom fault. His study area, however, is along the probable southeastern extension of the Camelsfoot fault whereas the Yalakom fault, interpreted to be the locus of younger dextral-slip displacement, is farther to the southwest. The interpretation shown in Figure 1-3-3 differs from that of Coleman (1990; Coleman and Parrish, 1991), who interpret the northeast-dipping Camelsfoot fault and underlying splays as the Yalakom fault.

Correlation of the Camelsfoot Range structural succession with that exposed around Konni Lake is based on: the gross three-fold succession comprising Methow basin/

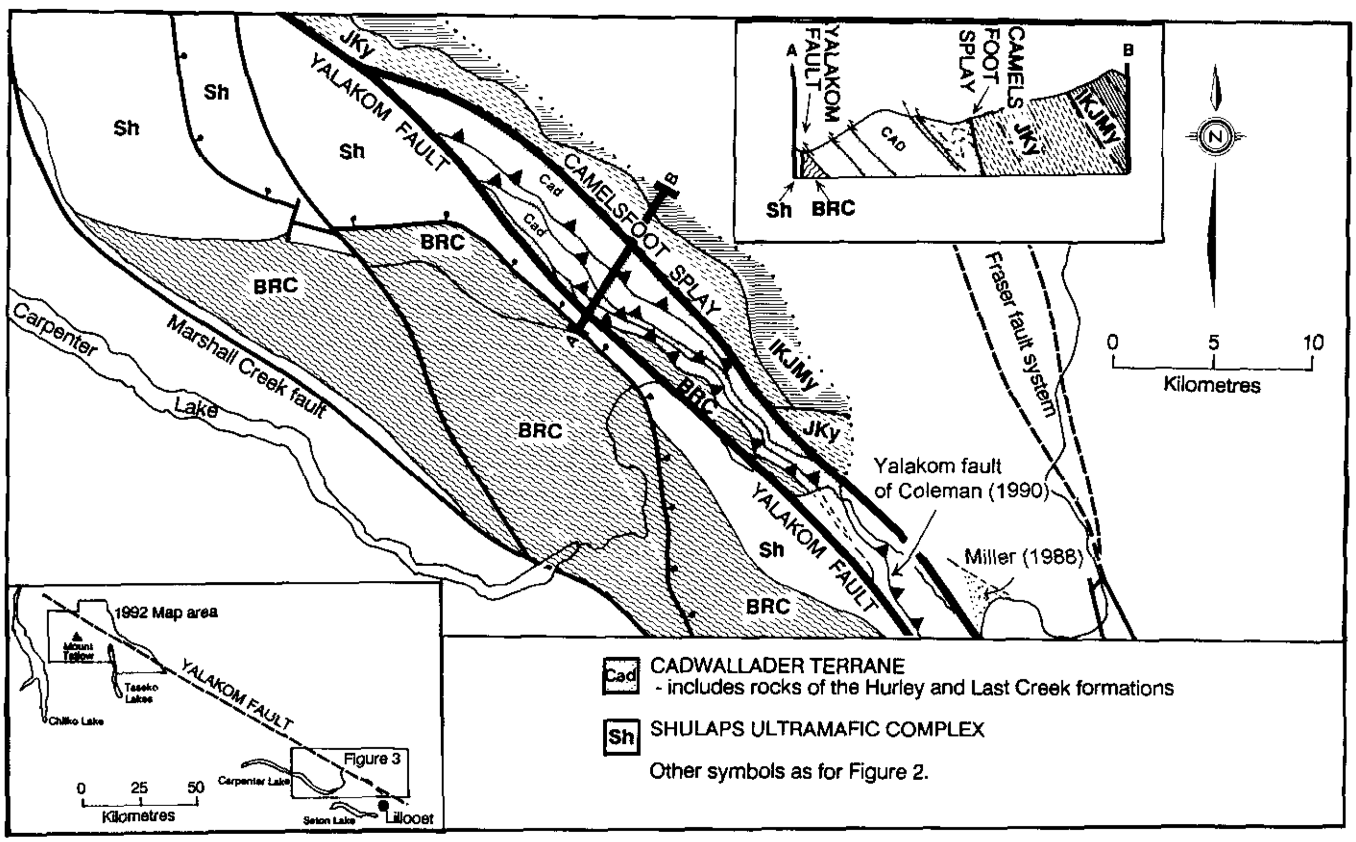

Figure 1-3-3. Geological relationships in the southwest Camelsfoot Range.

Cadwallader Terrane/Bridge River Complex; the internal stratigraphy of the Jura-Cretaceous Methow basin succession, which is virtually identical in the two areas; and the internal stratigraphy of the Cadwallader Terrane, which in each area comprises Hurley Formation directly overlain by cherty argillites of Last Creek formation (elsewhere in the region the Last Creek formation was deposited on the intervening Tyaughton Group). The dextral offset on the Yalakom fault derived from matching the cutoffs of the Konni Lake and Camelsfoot faults is 115 kilometres. This is considered approximate as the offset structures are not vertical and the synclinal disposition of the Jackass Mountain Group north of Konni Lake (Tipper, 1969) suggests that the Konni Lake fault may be folded and truncated again farther to the northwest. This estimate is similar to the lower limit of the 125 to 175 kilometre offset postulated by Kleinspehn (1985) whose criterion, similar facies of the Jackass Mountain Group, is one component of the structural succession used here. Other comparable estimates of dextral offset along the Yalakom-Hozameen fault system include the 120 kilometres between the Shulaps Ultramafic Complex and the Coquhihalla serpentine belt (Schiarizza *et al.*, in preparation), and 80 to 120 kilometres separation between belts of Middle Jurassic volcanics and associated plutons northwest of the Mount Tatlow area (Tipper, 1969; Schiarizza *et al.*, in preparation).

The timing of movement along the Yalakom fault is not closely constrained in the Mount Tatlow area; it is post Lower Cretaceous and pre-Miocene. Movement is thought to have occurred mainly in the Eocene, based on the timing of deformation established in metamorphic complexes associated with the fault to both the northwest (Friedman and Armstrong, 1988) and southeast (Coleman and Parrish, 1991).

MINERAL OCCURRENCES

FISH LAKE (MINFILE 92O 041)

Taseko Mines Limited drilled 7506 metres in ten holes on the Fish Lake porphyry copper-gold property in 1991, and in 1992 completed approximately 60 000 metres of NQ and BQ drilling in 121 holes. As a result of this work, on October 8, 1992, Taseko Mines announced a preliminary reserve estimate of 1.191 billion tons (1.08 billion tonnes) of ore with an average grade of 0.23 per cent copper and 0.41 gram per tonne gold.

The Fish Lake deposit is spatially and genetically related to an irregular, steeply dipping lenticular body of porphyritic quartz diorite which is surrounded by an east-west elongate complex of steep, southerly dipping, subparallel quartz feldspar porphyry dikes. This intrusive complex cuts andesitic flows and tuffs, together with a possibly coeval body of subvolcanic diorite porphyry. The potential orebody is essentially coextensive with a central zone of potassium silicate alteration, within which mafic minerals have been altered to biotite (which shows variable late alteration to chlorite). Secondary orthoclase is widely developed within the central porphyritic quartz diorite, mainly along quartz veinlets and microfractures.

An irregular annular zone of texture-destructive phyllic alteration occurs along the northern and eastern bodies of the deposit; variably developed propylitic alteration is widespread outside this phyllic zone. Numerous structurally controlled zones of late, pale sericite-ankerite alteration are also present, but are less abundant.

The Fish Lake deposit is oval in plan and is 1.5 kilometres long, up to 800 metres wide, and locally extends to a depth of 880 metres; its long axis parallels the east-west trend of the mineralizing intrusive complex. The deposit contains widespread bornite, almost everywhere subordinate to chalcopyrite, and is surrounded on its northern and eastern sides by a fairly well defined pyrite halo, which is essentially coextensive with the phyllic alteration zone. At least two-thirds of the deposit is in altered volcanic rocks, and in detail, high-grade intervals often envelope quartz feldspar porphyry dikes. A major low-angle fault forms the lower contact at depths between 750 and 850 metres.

VICK (MINFILE 92O 027)

The Vick prospect is a polymetallic vein showing hosted by andesitic flow breccias and feldspar crystal tuffs of the Powell Creek formation. It is located on a steep mountain directly west of the narrows at the north end of Lower Taseko Lake. Two exploration adits were driven into the east side of the mountain at about 1700 metres (5500 feet) elevation in 1935 (Lalonde, 1987). Exploration in the area surrounding the 2407-metre (7898-foot) peak began in the early 1970s. A four-wheel-drive access road to the peak was built around the south side of the mountain in the early 1980s.

The showings are gold, silver and copper-bearing quartz-sulphide veins within a northeast-striking shear zone that can be traced across the top of the peak and down the steep cliffs to the lower adits on the east face. Diorite dikes roughly parallel the fault zone. The quartz veins contain iron carbonates, pyrite and chalcopyrite concentrations parallel to the walls of the veins. Malachite and azurite are common. Specularite pseudomorphs pyrite in the upper parts of the vein shear system. Significant precious metal assays (up to 72 grams per tonne gold, up to 86 grams per tonne silver; McLaren, 1990) are generally associated with the sulphide-rich sections of the veins (Dolmage, 1936, Lalonde, 1987).

DIL/KNIGHT (MINFILE 92O 002)

The Dil and Knight claims are located on the ridges between Nadila and West Nadila creeks on the southern border of map sheet 92O/6. The area is underlain by shales and pebble conglomerates of the Taylor Creek Group, intruded by irregularly shaped bodies and dikes of hornblende feldspar porphyry.

Discovery of northeasterly trending boulder trains of banded, vuggy vein quartz sparked exploration for an epithermal precious metal target in the area in the early 1980s (McClintock, 1989). The vein quartz boulders are up to 50 centimetres across. Sulphides comprise less than 1 per cent of the veins, and include fine-grained pyrite and lesser arsenopyrite, stibnite and chalcopyrite. Samples contain metal concentrations as high as 19.3 grams per tonne gold and 35.4 grams per tonne silver, and rock and silt geochemical studies identified coincident anomalies of gold, arsenic and molybdenum in the area (McClintock, 1989). McClintock studied thin sections of altered rock mixed with the quartz float and a sample of feldspar porphyry, and recognized two distinct types of alteration: phyllic alteration with associated pyritization, and intense argillic alteration with associated silicification and carbonate alteration.

To date, no mineralized quartz veins have been found in place.

A 1990 mapping and sampling program by Inco Limited (Bohme, 1990) identified the Knob showing, a hydrothermally altered pebble conglomerate. The conglomerate is hornfelsed and silicified, carbonatized and pyritized; assayed samples yielded up to 54.43 grams per tonne gold and 8.3 grams per tonne silver, together with anomalous levels of copper, arsenic and bismuth (Bohme, 1990). Associated argillaceous sedimentary rocks are intensely fractured and carbonatized, but do not carry any anomalous metal concentrations.

SUMMARY

The Mount Tatlow map area is underlain by Mesozoic sedimentary and volcanic rocks of the Cadwallader Terrane, the Bridge River Complex, the Methow basin, the Tyaughton basin, the Silverquick formation and the Powell Creek formation. These rocks are intruded by several suites of Cretaceous(?) and Tertiary dioritic to granitic plutons, and are overlain by flat-lying Neogene plateau basalts of the Chilcotin Group. The northwest-striking, dextral-slip Yalakom fault is the most prominent structural feature of the map area.

Rocks of the Upper Triassic Hurley Formation (Cadwallader Terrane) and the Mississippian to Jurassic Bridge River Complex had not been recognized within the map area prior to our study. Their recognition in fault-bounded panels south of Methow basin strata on the southwest side of the Yalakom fault provides a compelling match with the same structural succession mapped northeast of the fault in the Camelsfoot Range (Schiarizza *et al.*, 1990a); this correlation indicates that there has been about 115 kilometres of dextral offset along the Yalakom fault. It confirms the earlier work of Kleinspehn (1985) who matched just one component of the structural succession, the Jackass Mountain Group of the Methow basin.

The Fish Lake porphyry copper-gold deposit occurs in a poorly exposed area on the northeast side of the Yalakom fault. The deposit is hosted by a multiphase dioritic to quartz dioritic intrusive complex and andesitic volcanic and volcaniclastic rocks that are separated from underlying sedimentary rocks (Jackass Mountain Group?) by a gently east-dipping fault. Intrusive rocks similar to those of the Fish Lake deposit outcrop for a short distance to the west and north, but are restricted to the northeast side of the Yalakom fault. The volcaniclastic rocks may be related to a poorly understood succession (Unit JKsv) that crops out locally to the west and north of Fish Lake, but these rocks have no obvious correlatives elsewhere in the map area. If the easterly dipping fault that bounds the Fish Lake deposit is a thrust, then correlatives might be found to the northeast, where volcanic successions of both Early and Late Cretaceous age are known (Hickson, 1992).

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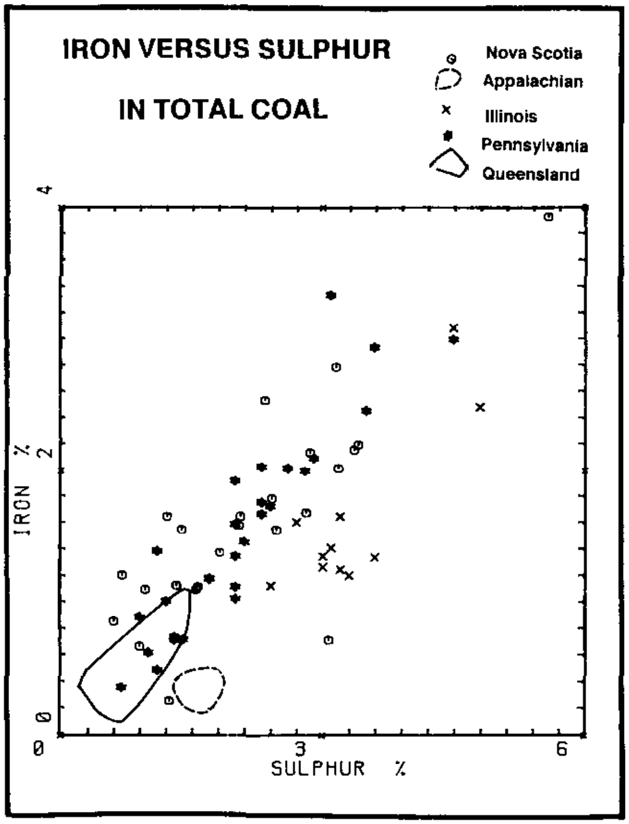

Figure 5-1-9. Plot of iron versus sulphur in some Canadian and international coals.

ratio correlates with iron, calcium and magnesium oxides and that iron oxide correlates with sulphur. Apparently most of the iron is in pyrite and the calcium and magnesium is in clays. *In contrast to British Columbia coals calcium oxide* correlates with base-acid ratios for the Queensland coals, possibly indicating a carbonate influence on base-acid ratio.

A plot of iron oxide versus sulphur concentrations (Figure 5-1-9) for Pennsylvania and Nova Scotia coals produces linear trends with data plotting near the pyrite line. Data from Illinois and Appalachian coals plot to the right of the pyrite line and indicate excess sulphur.

Base-acid ratios of eastern Canadian and eastern U.S.A. coals are high mainly because of varying amounts of pyrite and possibly iron carbonates. The coals do wash to a low ash and this provides flexibility for blending with British Columbia coals to reduce base-acid ratios.

BLENDING FOR IMPROVED CSR

Recent work investigated the effect on CSR values of coke of adding specific minerals to the parent coal samples (Price *et al.*, 1992). The addition of minerals such as calcite, pyrite and quartz changed the base-acid ratios of the doped coal sample and produced a change in the CSR values of the resultant coke. The CSR values were changed generally in amounts predicted by changes in the base-acid ratios and Equation A. This suggests that CSR values of coal blends can be estimated using the calculated blended base-acid ratio as long as there is not a wide disparity of rank or rheology.

Equation A predicts that CSR decreases nonlinearly as base-acid ratio increases (Figure 5-1-3). This means that there will be a better than additive improvement in CSR if a high base-acid ratio coal is blended with a low base-acid ratio coal. Table 5-1-2 can be used to provide an example. If two coals A (57% of blend) and B (43% of blend) with BAR/CSR values of 0.06/70.5(A) and 0.20/32.5(B) (line 1, Table 5-1-2) are mixed, then the resulting BAR/CSR values are 0.12/59.3. This is an 82 per cent improvement in the CSR value of coal B and the blend has an acceptable CSR value. There is adequate flexibility to produce blends with good CSR values for the range of base-acid ratios of British Columbia coals.

The study by Price *et al.* (1992) also indicated that the mineral used to produce a change in CSR also had an effect on the CSR value independent of its effect on base-acid ratio. Thus if the base-acid ratio was changed a constant per cent by addition of the appropriate amount of apatite, gypsum, calcite or lime, the decrease in CSR value depended on the mineral (least for apatite most for lime). Similar results were observed for iron. Siderite addition had less effect than pyrite addition which had less effect than adding iron oxide.

This has interesting implications when considering the effect of weathering on CSR. For a property so dependent on ash chemistry one might expect it to be resistant to weathering, which mainly affects coal, not mineral matter. This is not the case, and an answer might be that weathering changes the form of some of the base oxides. For example, pyrite weathers to iron sulphate and in this way increases the detrimental effect of the ash on CSR without actually changing the base-acid ratio.

DISCUSSION

Coke strength after reaction is an important measure of coke quality, especially at a time when the ratio coke(kilogram)/ton hot metal is being decreased by the use of pulverized coal injection (PCI).

A sensitivity analysis using an empirical equation that predicts CSR values provides for a better understanding of the relative importance of ash content, base-acid ratio, rank and fluidity in influencing the resultant CSR. The base-acid ratio of the coal is one of the most important coal properties effecting the CSR of the resultant coke.

Correlation analysis of ash oxide data can indicate which oxides are responsible for variations in base-acid ratio. It then becomes important to identify the mineral host for these oxides. This can be achieved using correlation analysis, iron-sulphur plots, normative calculations or low-temperature ashing combined with x-ray diffraction. Often variations in base-acid ratio are correlated with variations in iron oxide concentration, probably present as pyrite or an iron carbonate. This information may lead to ways of selecting or washing run-of-mine coal for improved CSR.

On-line ash analyzers in coal wash-plants may be able to measure changes in iron content. From these data it might be possible to predict fluctuations in the CSR values of the clean coal before it reaches the customer.