GEOLOGY OF THE BABINE LAKE - TAKLA LAKE AREA, CENTRAL BRITISH COLUMBIA (93K/11, 12, 13, 14; 93N/3, 4, 5, 6)

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(British Columbia Geological Survey Branch contribution to the Nechako NATMAP Project)

KEYWORDS: Bedrock mapping, Nechako Natmap, Stikine Terrane, Asitka Group, Takla Group, Hazelton Group, Cache Creek Complex, Sitlika assemblage, Trembleur ultramafic unit, North Arm succession, ophiolite, sheeted dikes, Fort showing.

INTRODUCTION

This paper summarizes the results of bedrock mapping in the area between Babine Lake and Takla Lake in central British Columbia (Figure 1). This work was done as part of the Nechako Natmap project (see MacIntyre and Struik, 1999, this volume). The 1998 bedrock mapping crew was comprised of Don MacIntyre and Paul Schiarizza as co-leaders and geology students Angelique Justason (Camosun College), Sheldon Modeland (University of Victoria), Stephen Munzar (University of British Columbia) and Deanne Tackaberry (University of Victoria). The primary objective in 1998 was to complete mapping in the northwest quadrant of the Fort Fraser (93K) map sheet. This work was started in 1997 with preliminary mapping of the Tochcha Lake (93K/13) map sheet (MacIntyre *et al*., 1998). It also builds on mapping by Ash and Macdonald (1993) and Ash *et al*. (1993) around Stuart Lake, and incorporates data gathered by the GSC Natmap crew in the vicinity of Trembleur Lake (Hrudey and Struik, 1998). Within most of the area, however, the only previous regional mapping dates back to Armstrong (1949).

From early June until the end of August, the bedrock geology of NTS map sheets 93K/11, 12, 14 and 93N/3 (Figure 1) were mapped at 1:100 000 scale. In addition, fill-in mapping was done in map sheets 93K/13, 93N/4 and 93N/5, which had been largely completed in 1997 (MacIntyre *et al*., 1998; Schiarizza *et al*., 1998). This work provides continuity between Natmap programs concentrated on the Sitlika assemblage in west-

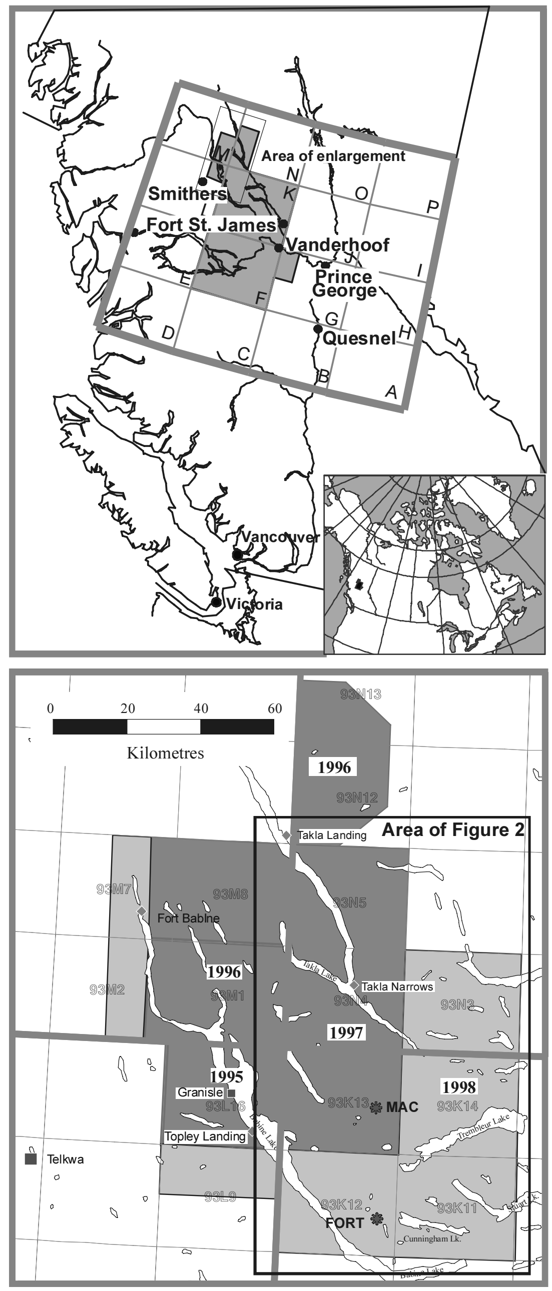

Figure 1. Location of bedrock mapping completed in 1998. Inset shows location relative to the Nechako Natmap Project (light grey shading), central British Columbia. Also shown is the area covered by Figure 2.

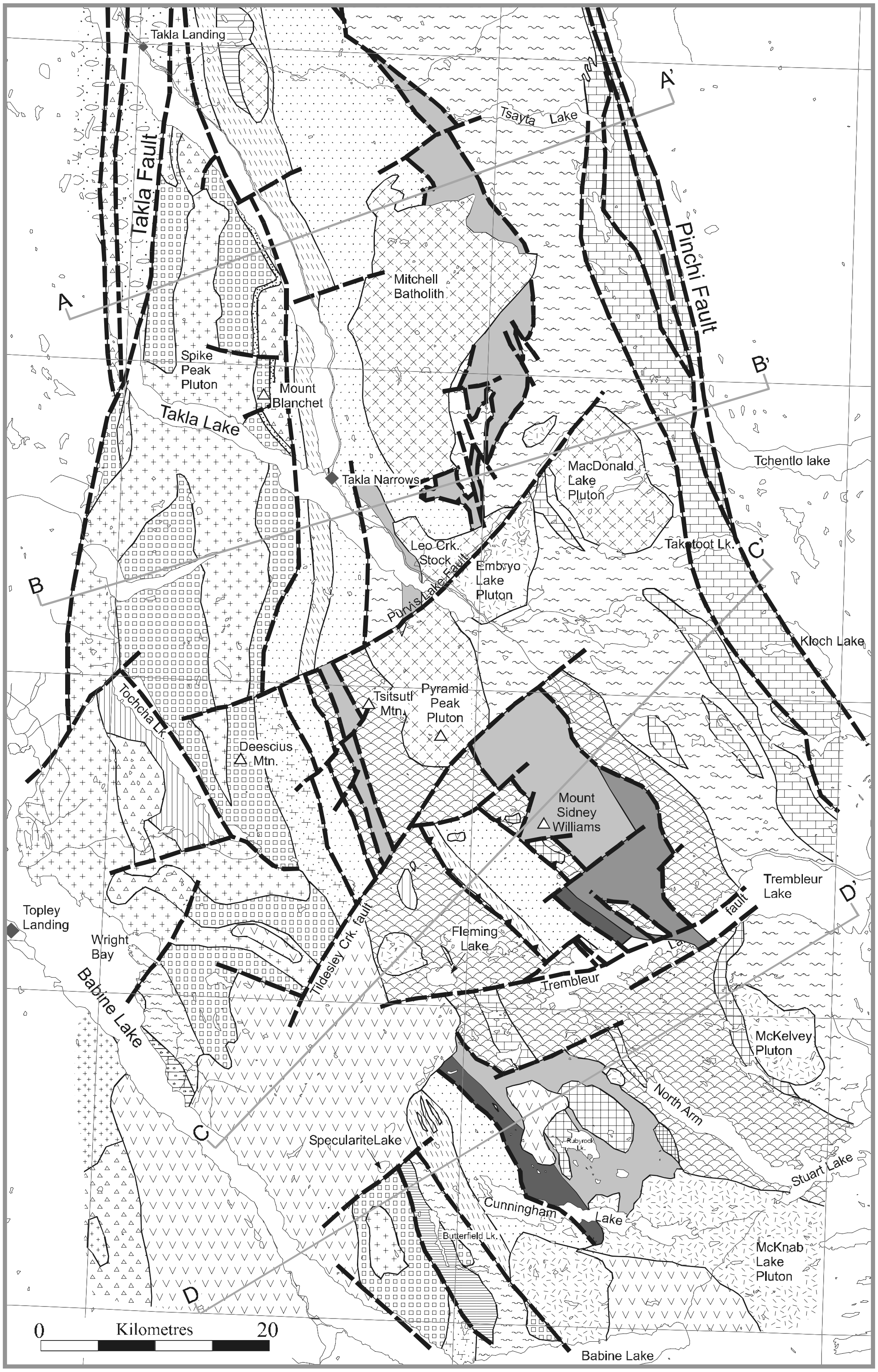

Figure 2a. General geology of the Babine-Takla lake area. See Figure 2b for legend.

OVERLAP ASSEMBLAGES

Eocene

basalt, andesite, ash flow, minor debris flow, conglomerate, mudstone

K-feldspar-biotite porphyry, biotite-hornblende-feldspar porphyry

Upper Cretaceous

Sustut Group

chert pebble conglomerate, minor sandstone, shale

Early Cretaceous

Mitchell Range intrusions: medium to coarse-grained granite and granodiorite; locally includes diorite and quartz diorite.

Late Jurassic to Early Cretaceous

Francois Lake suite: granite, quartz monzonite, biotite granodiorite, quartz porphyry

Middle Jurassic

McKnab Lake intrusive suite: quartz diorite, tonalite, diorite

STIKINE TERRANE

Middle Jurassic

Spike Peak intrusive suite: red to pink monzonite, quartz monzonite, hornblende diorite; locally porphyritic (176-167 Ma.)

Late Triassic to Early Jurassic

Topley intrusive suite: pink to grey, K-feldspar megacrystic granite, quartz monzonite; monzonite; varies from fine-grained equigranular to porphyritic (230-195 Ma.)

Lower to Middle Jurassic

Hazelton Group

subaerial andesite to dacite flows and associated pyroclastic rocks, feldspathic fossiliferous siltstone and sandstone; volcanic conglomerate; typically feldspar or feldspar-pyroxene phyric; locally foliated.

Upper Triassic to Lower Jurassic

quartzose-feldspathic turbidites; wacke, argillite, chert and limestone clast polymictic conglomerate

Upper Triassic

Takla Group

submarine to subaerial basalt and basaltic andesite flows and associated pyroclastic and epiclastic rocks; minor mudstone and siltstone interbeds; typically pyroxene to pyroxene-feldspar phyric; some coarse-grained bladed feldspar phyric andesite; locally deformed to chlorite schist; may be equivalent to the Savage Mountain and/or Moosevale formations.

marine siltstone, mudstone, cherty argillite; minor limestone, chert and chert-limestone clast conglomerate; locally strongly deformed; may be equivalent to the Dewar Peak formation.

Late Triassic

Tochcha Lake stock: foliated hornblende diorite (219 Ma.)

Paleozoic and/or Triassic

Butterfield Lake intrusive complex: pyroxenite, hornblende gabbro, diorite, chlorite schist

Taltapin metamorphic complex: chlorite-feldspar-amphibole schist, amphibolite, greenstone

Upper Pennsylvanian to Lower Permian

Asitka Group

massive grey limestone; argillaceous limestone, chlorite schist; minor felsic tuff or flows, metasiltstone, metachert.

CACHE CREEK TERRANE

SITLIKA ASSEMBLAGE

Upper Triassic to Lower Jurassic

Clastic unit: medium to dark grey slate, phyllite; banded siltstone, sandstone and conglomerate; minor limestone and green chloritic phyllite; locally contains felsic volcanic and plutonic clasts; distal to proximal turbidite succession.

Early Triassic

Light grey, medium to coarse-grained tonalite

Late Permian or Early Triassic

Medium grained epidote-chlorite-feldspar schist to semischist; sericite-chlorite-feldspar schist; weakly foliated chloritized hornblende diorite

Permian to Lower Triassic

Volcanic unit: medium to dark green chlorite schist, fragmental chlorite schist and pillowed metabasalt; chlorite-sericite schist containing felsic metavolcanic fragments; lesser amounts of quartz-sericite schist, quartz-feldspar porphyry, flow banded metadacite, metasandstone and metachert.

CACHE CREEK COMPLEX

Permian to Triassic?

North Arm succession

massive to pillowed basalt flows with interbeds of pillow breccia, chlorite schist, chert, limestone and graphitic phyllite; includes greenstone dikes and sills; minor metagabbro, amphibolite, serpentinite and listwanite.

sheeted diabase dike complex.

gabbro, diorite, diabase; locally includes clinopyroxenite, amphibolite, tonalite.

Trembleur Ultramafic Unit

variably serpentinized harzburgite and dunite; serpentinite, serpentine-magnesite-talc schist; locally includes clinopyroxenite, gabbro, greenstone, diabase, amphibolite, chert, limestone, listwanite, nephrite

mainly carbonate-talc altered ultramafic rocks; minor listwanite.

foliated serpentinite, commonly with lozenges of massive serpentinized ultramafite.

Permian to Jurassic

Phyllite-chert unit: light to medium grey quartz phyllite, platy quartzite and metachert; lesser amounts of recrystallized limestone, dark grey phyllite, massive to pillowed greenstone, fragmental greenstone and chlorite schist; minor amounts of meta sandstone.

Pennsylvanian to Permian

massive limestone, minor basalt

Figure 2b. Legend to accompany Figure 2a (facing page).

ern 93N map sheet (Schiarizza and Payie, 1997; Schiarizza *et al.*, 1998), the Babine porphyry belt of Stikine Terrane in eastern 93L and 93M map sheets (MacIntyre *et al.*, 1996, 1997; MacIntyre, 1998), and the Cache Creek Terrane in the eastern 93K map sheet (Struik and Orchard, 1998, and references therein).

The information contained in this report is preliminary; the results from samples submitted for radiometric dating and microfossil extraction have not yet been received. This forthcoming data may change or refine some of the interpretations presented here.

REGIONAL GEOLOGIC SETTING

The northwest quadrant of the Fort Fraser map sheet (93K) and southwest quadrant of the Manson River map sheet (93N) straddle the boundary between Stikine and Cache Creek terranes. The oldest rocks exposed along the eastern margin of the Stikine Terrane are upper Paleozoic carbonates and island-arc volcanic and volcaniclastic rocks of the Asitka Group. Overlying the Asitka Group are basaltic calc-alkaline to alkaline island arc volcanic and sedimentary rocks of the Middle to Upper Triassic Takla Group and mafic to intermediate calc-alkaline volcanic and sedimentary rocks of the Lower to Middle Jurassic Hazelton Group. These arc successions are overlain by predominantly marine clastic sedimentary rocks of the upper Middle Jurassic to Lower Cretaceous Bowser Lake and Skeena groups, which in turn are overlapped by Upper Cretaceous to Paleocene nonmarine clastic sedimentary rocks of the Sustut Group or Upper Cretaceous continental arc volcanic rocks of the Kasalka Group. Younger rocks, which overlie both the Stikine Terrane and adjacent Cache Creek Terrane, include Eocene volcanic rocks of the Ootsa Lake and Endako groups, as well as Miocene-Pliocene plateau basalts of the Chilcotin Group.

The Cache Creek Terrane includes the Sitlika assemblage in the west and the Cache Creek Complex to the east. The Sitlika assemblage consists of Permo-Triassic bimodal volcanic rocks overlain by Upper Triassic to Lower Jurassic clastic sedimentary rocks. This assemblage is structurally overlain by a poorly dated, but partially age-equivalent ophiolitic sequence that forms the western part of the Cache Creek Complex. Eastern elements of the Cache Creek Complex include a Permian to Lower Jurassic succession of predominantly pelagic metasedimentary rocks and thick Pennsylvanian - Permian carbonate sequences associated with ocean island basalts. Structural imbrication of Cache Creek Terrane, across predominantly west-directed thrust faults, occurred in Early to Middle Jurassic time, and was approximately coincident with its amalgamation with the adjacent Stikine Terrane.

Intrusive rocks are common in the region and belong to several distinct suites. In the current study area Late Triassic-Early Jurassic and Middle Jurassic plutons assigned to the Topley and Spike Peak intrusive suites cut rocks of the Stikine Terrane; whereas the adjacent Cache Creek Terrane is host to at least three distinct plutonic suites of late Middle Jurassic, Late Jurassic-Early Cretaceous and Early Cretaceous age.

LITHOLOGIC UNITS

Stikine Terrane

In the current study area the Stikine Terrane is represented by the upper Paleozoic Asitka Group, Middle to Upper Triassic Takla Group and Lower Jurassic Hazelton Group.

Asitka Group

The Asitka Group, as defined by Lord (1948), includes aphanitic basalts, rhyolites, breccia, feldspar porphyry, chert, limestone and argillites of mid-Pennsylvanian to Early Permian age. The type area is located between the Asitka and Niven rivers in the northeast McConnell Creek map area. Diakow and Rogers (1998) describe a two fold subdivision in the McConnell Range. There, the Asitka Group is comprised of a lower volcanic unit of mainly aphanitic basalt and basaltic andesite with minor interbeds of fragmental and felsic volcanic rocks and marine sediments. The upper part of the Asitka Group is sedimentary and is characterized by a lower member of massive grey limestone overlain by thinly bedded chert, tuffaceous siltstone and sandstone, siliceous mudstone and carbonaceous chert. The contact with overlying Takla sediments is believed to be a disconformity with a depositional hiatus ranging from Early Permian to Late Triassic. However, west of the current study area at the Fulton river dam site, a bedded chert that overlies Early Permian limestone of the Asitka Group contains Middle Triassic radiolarians (Fabrice Cordey, personal communication, 1996). This suggests that some of the sedimentary rocks included in the upper sedimentary unit of the Asitka Group may actually be Triassic in age and should, therefore, be included with the Takla Group.

Within the current study area, rocks assigned to the Pennsylvanian to Permian Asitka Group underlie the northwest corner of the 93K/12 map sheet, southeast of Wright Bay on Babine Lake (Figure 2). Here, a belt of greenschist facies metasedimentary and metavolcanic rocks crop out as a series of northwest trending ridges with the best exposures occurring in areas that have been logged and burned. This belt of metamorphic rocks, which dips moderately to the northeast, is bounded to the west by an area underlain by massive grey limestone and to the east by pyroxene phyric flows of the Takla Group. The limestone is lithologically identical to one in the Fulton Lake area west of Babine Lake that contains Early Permian (Sakmarian and Artinskian) conodonts (Orchard, 1996; MacIntyre *et al.*, 1996). A similar age is implied for the limestone in the northwest corner of the 93K/12 map sheet. These limestone members are assigned to the Pennsylvanian-Permian Asitka Group which typically has limestone beds near its upper contact with the Upper Triassic Takla Group (Diakow and Rogers, 1998).

Photo 1. Paul Schiarizza collecting a U-Pb geochronology sample from a flow banded phyolite lense within chlorite schists of the Asitka Group, northwest corner, 93K/12 map sheet.

The metavolcanic rocks east of the limestone in the 93K/12 map sheet are predominantly chlorite schists and phyllites which locally have layers containing flattened felsic clasts. A sample for U-Pb isotopic dating was collected from a lens of feldspar phyric, banded rhyolite within the chlorite schist succession (Photo 1). The protoliths for these metamorphic rocks are interpreted to be aphanitic mafic volcanics with lesser associated felsic pyroclastic rocks, a lithological mix that is typical of the lower part of the Asitka succession in the McConnell Creek map area (Diakow and Rogers, 1998). If these correlations are correct it implies the presence of a northeast dipping, overturned antiform cored by metavolcanic rocks of the Asitka Group. The western overturned limb of this antiform is mainly massive limestone; the eastern upright limb near the contact with Takla Group rocks is medium to thin bedded, metachert and metasiltstone (Photo 2). These metasedimentary rocks may comprise an upper member of the Asitka Group; alternatively they are a lower deformed sedimentary member of the Takla Group, possibly the Dewar Peak Formation. These metasediments are similar to those overlying the Early Permian limestone at the Fulton River dam site in the Fulton Lake map sheet (MacIntyre *et al.*, 1996). There, cherts have yielded Middle Triassic radiolarians and are included with the Takla Group.

The metavolcanic rocks assigned to the Asitka Group are intruded by numerous dikes and sills of pyroxenite, coarse grained hornblende gabbro and diorite. These intrusions are believed to be comagmatic with overlying pyroxene phyric flows of the Takla Group.

Photo 2. Well bedded metachert and metasiltstone, northwest corner, 93K/12 map sheet. These rocks apparently underlie pyroxene phyric flows of the Takla Group.

Taltapin Metamorphic Complex and Butterfield Lake Pluton

Metamorphic rocks that crop out along the east end of Babine Lake were examined by Struik and Erdmer (1990), who noted that they were at higher metamorphic grade than is typical for this part of the Intermontane Belt. These medium grade metamorphic rocks, consisting of amphibolite, marble, quartzite and foliated diorite, were traced southeastward into the Tintagel (93K/6) map sheet by Hrudey *et al,* (1999), who assign them to the Talatapin metamorphic complex. They extend northwestward into the present map area as a narrow belt that encompasses Butterfield Lake (Figure 2). This belt is juxtaposed against the Sitlika assemblage to the east, across an inferred fault that in part follows Gullwing Creek. It is bounded by Eocene basalt to the north, and by exposures of Takla Group to the west. Variably foliated augite-phyric metabasalts assigned to the Takla Group also occur as two separate outliers in the eastern part of the belt. This suggests that the Taltapin metamorphic complex, which had been included in the Cache Creek Group by Armstrong (1949) and Struik and Erdmer (1990), actually comprises part of the Stikine Terrane.

Much of the Taltapin belt within the present map area consists of ultramafic to mafic intrusive rocks assigned to the Butterfield Lake pluton (Figure 2). The pluton consists mainly of weakly to strongly foliated gabbro and diorite, but pyroxenite, locally cut by dikes of gabbro and diorite, predominates in the west. Dikes and pods of fractured to foliated tonalite locally cut the ultramafic to mafic rocks and may be the youngest phase of the pluton; alternatively, they may represent a separate intrusive event. The Butterfield Lake pluton is undated, but is suspected to be of Late Triassic age, possibly correlative with the Tochcha Lake pluton (described in a following section).

The western margin of the Butterfield Lake pluton consists of foliated serpentinite that is inferred to mark a fault contact with adjacent volcanic rocks of the Takla Group. Along the southern boundary of the map area, however, the pluton truncates a west-dipping contact that juxtaposes the Takla volcanics above an assemblage that includes marbles, amphibolites, quartz-chlorite schists and local metachert units. Although rocks on both sides of the contact are strongly foliated and locally sheared, this may be a stratigraphic contact between the Takla Group and underlying Asitka Group. Eastern exposures of the Taltapin metamorphic belt are dominated by fine-grained amphibolites, chlorite schists, and chlorite-amphibole-feldspar schists that appear to have been derived from a complex assemblage of dioritic plutonic rocks and metavolcanic or metasedimentary rocks. The two outliers of augite-phyric metabasalts within this part of the belt suggest that these rocks are stratigraphically or structurally beneath the Takla Group. It is suspected, therefore, that the Taltapin metamorphic complex consists mainly of metasedimentary and metavolcanic rocks derived from the Asitka Group, together with plutonic rocks that correlate with the Butterfield Lake pluton.

Photo 3. Volcanic breccia with moderately flattened, subrounded clasts of pyroxene phyric basalt, typical of the lower part of the Takla Group volcanic succession, northwest corner, 93K/12 map sheet.

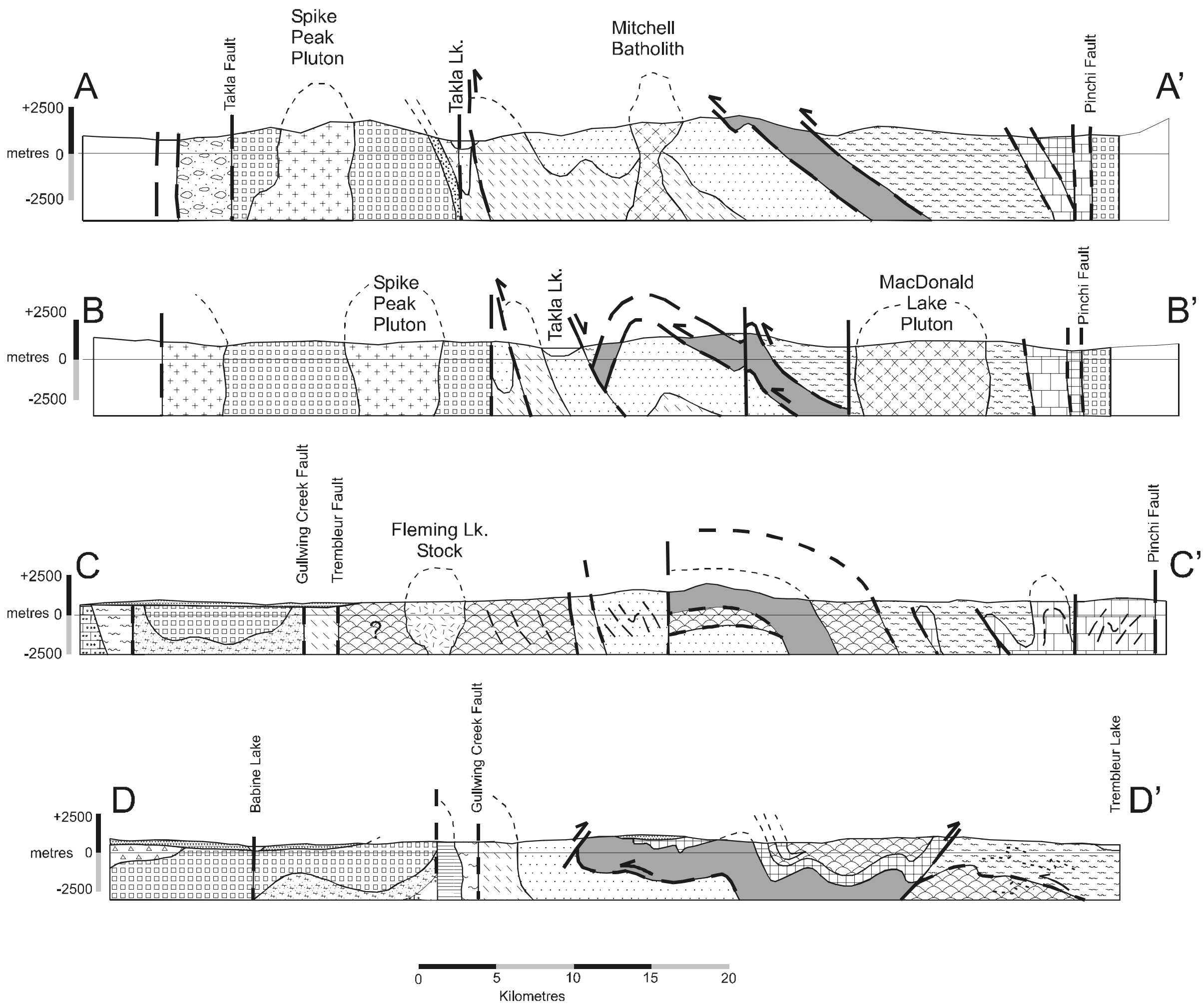

Figure 3. Interpretive structural cross sections, Babine-Takla lakes area. See Figure 2a for location of sections and Figure 2b for legend.

Takla Group

The Takla Group was first defined by Armstrong (1946, 1949) in the Fort St. James map-area. The type area is located west of Takla Lake in the 93N/4 and 93N/5 map sheets (Armstrong, 1949). As originally defined, the Takla Group included upper and lower divisions of arc related volcanic and sedimentary rocks ranging in age from Late Triassic to Late Jurassic, a subdivision also used by Lord (1948) in the McConnell Creek map area. Monger (1976) and Monger and Church (1977) redefined the Takla Group to include only sedimentary and basaltic volcanic rocks of Late Triassic age; the Jurassic part of the Takla Group was assigned to the Hazelton Group. Monger and Church further subdivided the Takla Group into the Dewar, Savage Mountain and Moosevale Formations. The Dewar Formation, which occurs at the base, is the most widespread, and includes thin to medium-bedded dark grey or greenish grey, brown weathering volcanic sandstone or bedded tuff, siltstone and interbedded argillite. It is a marine turbiditic succession up to 300 metres thick, and, near its base, consists mainly of graphitic and pyritic argillite with silty and sandy laminae and interbeds of argillaceous limestone and cherty argillite. Fossils collected from the Dewar Formation are upper Carnian in age (Monger and Church, 1977).

The Dewar Formation is overlain by and in part interbedded with the Savage Mountain Formation.

Photo 4. Outcrop of lapilli tuff with clasts of pink, flow-banded rhyolite, feldspar phyric andesite and fine-grained monzonite in a greenish grey crystal-ash matrix exposed at Wright Bay on Babine Lake. This lithology is typical of much of the Wright Bay succession.

This succession is up to 3000 metres thick and includes massive submarine volcanic breccias, aphanitic and augite-feldspar phyric pillowed and massive basalt flows and minor interbedded volcaniclastic sedimentary rocks and tuffs. The volcanic rocks are characterized by the presence of augite phenocrysts, which occasionally reach 1 centimetre in diameter. Coarse, bladed feldspar phyric basalt flows, with feldspar phenocrysts up to 3 centimetres, are also locally present.

The Savage Mountain Formation, which in places becomes subaerial near its upper contact, is overlain by the Moosevale Formation. The contact varies from gradational to sharp. Fossils from the Moosevale Formation, which is up to 1800 metres thick, are Late Triassic (Norian). Overall, the formation is more intermediate in composition than the underlying Savage Mountain Formation, and includes varying amounts of massive, red, green and maroon volcanic breccia, graded red and grey sandstone, argillite, fossiliferous mudstone, red volcanic conglomerate and lahar. Clasts in the fragmental volcanic rocks and conglomerates are typical of the underlying Savage Mountain Formation. The Moosevale Formation is mainly marine near its base, becoming non-marine up section.

Augite phyric dark green to grey basaltic flows, volcanic breccias, tuffs and minor interbedded volcaniclastic sedimentary rocks crop out along the western half of the Tochcha Lake map sheet and are correlated with the Savage Mountain Formation of the Takla Group. These rocks are at the southern end of a 65 kilometre long belt that can be traced northward into the 93N/4 and 93N/5 map sheets, terminating at Takla Landing on Takla Lake (Figure 2). Within this belt the Takla Group succession can be divided into four mappable subdivisions. The base of the succession, which is not well-exposed, is comprised of graphitic cherty argillite, argillaceous limestone, calcareous siltstone, mudstone and minor pebble conglomerate that are probably correlative with the Dewar Formation. Similar sedimentary beds also interfinger with overlying, predominantly volcanic units. In general these marine sedimentary rocks are overlain by a thick volcanic succession. The base of this succession is predominantly dark green, pyroxene rich basaltic flows and related breccias. These grade upward into a middle unit of interbedded volcanic breccia, agglomerate, volcanic conglomerate and lapilli tuff, all of which contain abundant pyroxene-phyric basalt clasts. The upper part of the volcanic succession is mainly brown to buff weathering, greenish grey to purplish pyroxene-feldspar to hornblende-pyroxene-feldspar phyric andesite flows, volcanic breccias and lapilli tuffs. The andesitic flows locally have a trachytic texture comprised of 35 to 40 percent, 4 to 6 millimetre feldspar laths. Mike Villeneuve of the Geological Survey of Canada, Ottawa, reports that hornblende from a hornblende-pyroxene-feldspar phyric andesite flow in the Fulton Lake area gave a 208 ± 2 Ma Ar-Ar isotopic age (MacIntyre *et al.*, 1996). This suggests the top of the Takla succession is close to the Triassic-Jurassic boundary.

The best exposures of the upper part of the Takla Group are on the west slope of Deescius Mountain (Figure 2), where several hundred metres of massive pyroxene-feldspar phyric andesite flows and breccias are exposed. Thin sedimentary interbeds between flows indicate the succession dips moderately to the northeast. These volcanic rocks are underlain to the southwest by a poorly exposed interval of mudstone, siltstone and conglomerate. These sediments overlie aphanitic basalt and pyroxene phyric flows typical of the lower part of the Takla Group volcanic succession. Near the top of this sedimentary interval is a foliated pebble conglomerate that contains flattened clasts of limestone and chert. A sample of limestone clasts extracted from the conglomerate yielded Norian conodonts (M.J. Orchard, written communication, 1998)

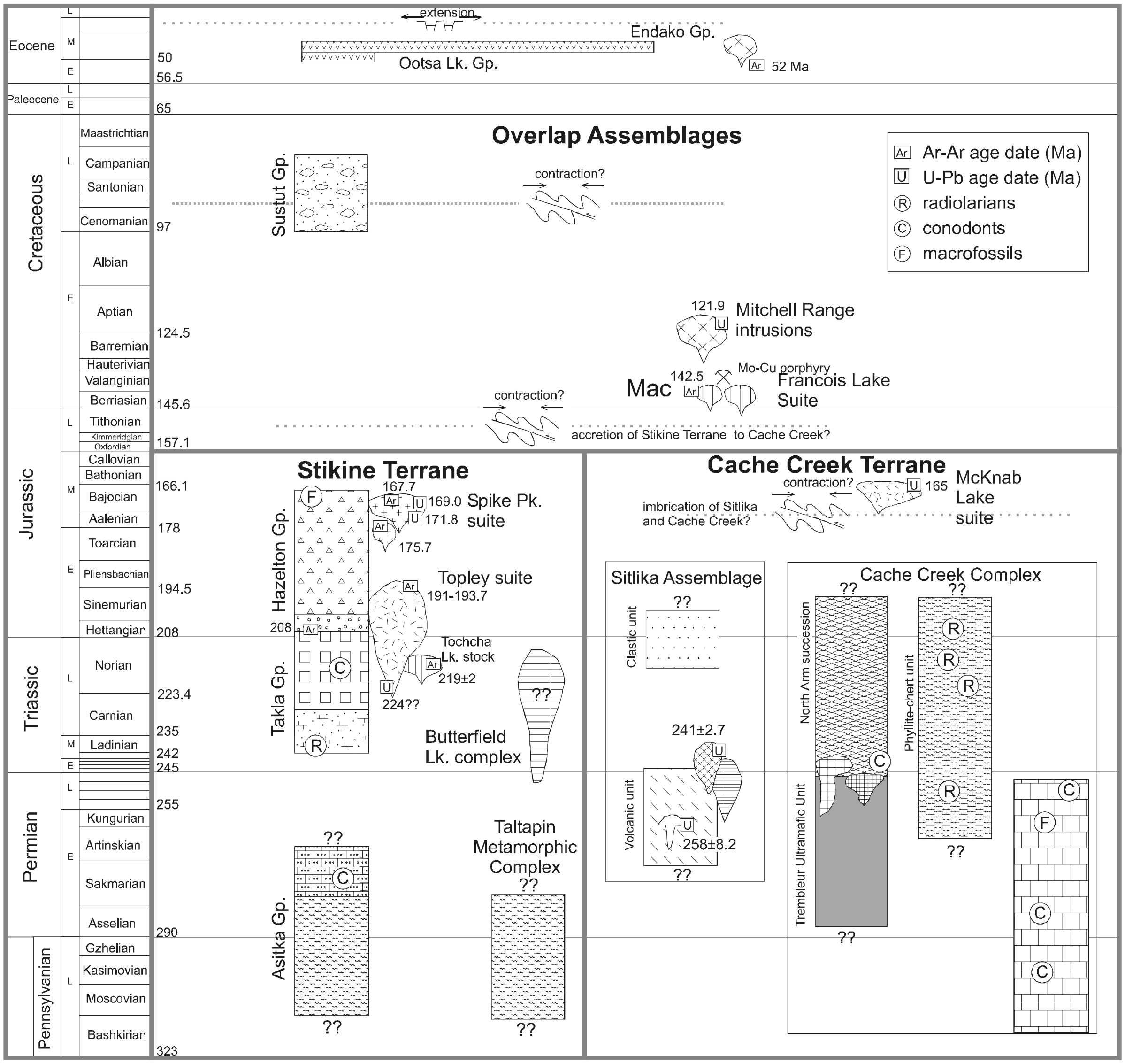

Figure 4. Schematic illustration of the generalized stratigraphy, plutonic and structural events of the Babine Lake - Takla Lake area. See figure 2b for the legend.

suggesting that the clasts are locally derived from limestone beds within the Takla Group.

East of Deescius Mountain is a belt of folded, well bedded siltstone, argillaceous limestone and cherty argillite. These rocks, which are only exposed along logging roads southeast of Deescius Mountain, are in fault contact with the upper part of the Takla Group. East of the valley of Gloyazikut Creek they are in apparent fault contact with the clastic unit of the Sitlika assemblage. These sedimentary rocks are tentatively included with the Takla Group.

Pyroxene phyric mafic volcanic rocks, typical of the Upper Triassic Takla Group, crop out in the northwest and southeast corners of the 93K/12 map sheet. In the southeast corner of 93K/12, a good section through part of the Takla Group succession is exposed along a new logging road located between Butterfield and Babine lakes. There, the Takla Group consists predominantly of green weathering, chloritic basalt flows, breccias and tuffs with 60 to 70 percent, 2 to 4 millimetre pyroxene crystals. Locally the flows and tuffs are strongly deformed to a chlorite schist with stretched pyroxene phenocrysts. Foliation and bedding trends suggest the Takla succession is dipping moderately to steeply southwestward. To the east, the contact with the Butterfield Lake pyroxenite-gabbro-diorite pluton, which is exposed in road cuts at the Fort prospect, is interpreted to be a high angle fault. Along the shores of Babine Lake, a southwest dipping section of pyroxene rich schists and phyllites interpreted to be deformed Takla Group is underlain by interbedded graphitic phyllites, argillaceous limestone and marble. The latter are well exposed at Boling Point and are tentatively mapped as the lower sedimentary unit of the Takla Group (Figure 2); alternatively they may be an upper member of the Asitka Group.

The Takla Group rocks that crop out in the northwest corner of the 93K/12 map sheet overlie metavolcanic rocks of the Asitka Group. Here, the succession dips moderately to the northeast. The statigraphic succession in this area is the same as that observed further north in the Tochcha Lake area. The lowest volcanic members are dark green, relatively coarse grained, pyroxene phyric flows and related volcanic breccias (Photo 3). These grade up section into finer-grained, brown weathering feldspar-pyroxene phyric flows, volcanic breccias and lapilli tuffs that are probably andesitic in composition. Locally, these rocks have a trachytic texture comprised of 2 to 4 millimetre feldspar laths in a finer-grained, pyroxene-bearing groundmass. These intermediate volcanic rocks may correlate with the Moosevale Formation of the Takla Group; alternatively they may be a lower member of the Jurassic Hazelton Group.

The Takla Group is well exposed on Mount Blanchet in the 93N/4 map sheet. There, the Takla succession, which dips moderately to the east, is largely intact and less deformed than exposures in the southern Babine Lake area. Exposures on the west slope of the mountain comprise more than 500 metres of massive, lenticular feldspar-pyroxene phyric basalt to andesite flows with minor thin-bedded tuffaceous sedimentary intervals. The base of the succession is not exposed and to the west it is intruded by Middle Jurassic hornblende diorite. Near the top of Mount Blanchet and down its eastern slope, the massive flows are overlain by thin bedded, finer-grained pyroxene-bearing tuffs and tuffaceous clastic sediments.

Quartzose-feldspathic turbidites

A distinctive succession, up to 100 metres thick, of medium to thick bedded quartzose-feldspathic turbidites crops out on the east slope of Mount Blanchet and along the western shores of the main arm of Takla Lake. These turbidites, which apparently occupy a stratigraphic position between the Upper Triassic Takla Group and Lower Jurassic Hazelton Group, are comprised of beds of siliceous fine-grained siltstone, quartz wacke and chert clast-bearing pebble conglomerate separated by thin intervals of mudstone and siltstone. The finer-grained siltstone members are locally cross laminated. The composition of clasts in the pebble and granule conglomerates varies from predominantly chert to a mixture of chert and limestone with lesser feldspar phyric andesite clasts. The clasts may have been derived from the Asitka or Takla groups of Stikine Terrane, or from the adjacent Cache Creek Terrane. Limestone clasts collected from a conglomerate bed along Takla Lake are being processed for conodont extraction in an attempt to constrain their age.

Tochcha Lake Pluton

Medium-grained, equigranular hornblende-biotite diorite underlies the hills along the west side of Tochcha lake. The diorite has a pronounced mineral lineation that is defined by the alignment of hornblende and biotite. Xenoliths of biotite microdiorite, up to 10 centimetres in diameter, have indistinct (resorbed?) margins and are abundant in the intrusive. Fine-grained, pink aplitic dikes cut the diorite. Mike Villeneuve of the Geological Survey of Canada, Ottawa, reports an Ar-Ar isotopic age of 219 ± 2 Ma for hornblende from the diorite (MacIntyre *et al.*, 1996). If this age is representative it indicates that the Tochcha Lake diorite is approximately the same age as the Takla volcanic rocks that it intrudes and may be comagmatic with the volcanic rocks. Additional dating is required to verify this correlation. The 219 Ma Ar-Ar isotopic age is similar to dates determined for diorites of the Boer Lake intrusive suite in the Endako area (Mike Villeneuve, personal communication, 1997).

Hazelton Group

The Hazelton Group (Leach, 1910) is a calcalkaline island-arc assemblage that evolved in Early to Middle Jurassic time. In the current study area, and the McConnell Creek map area to the north (94D), it rests unconformably to disconformably on volcanic and sedimentary strata of the Upper Triassic Takla Group (MacIntyre *et al.*, 1996).

Tipper and Richards (1976) divided the

Hazelton Group into the Telkwa, Nilkitkwa and Smithers formations based on lithology, fossil assemblages and stratigraphic position. Of these only the Telkwa Formation has been mapped in the current study area. Here, as elsewhere, the Telkwa Formation is comprised of subaerial to submarine, predominantly calcalkaline volcanic rocks.

Wright Bay succession

A distinctive succession of subaerial volcanic rocks is exposed on the shores of Wright Bay and in several localities between Wright Bay and Tochcha Lake. This succession, which at Wright Bay dips moderately to the west, is comprised of a lower member of flow banded rhyolite that may in part be intrusive, a middle member of feldspar phyric lapilli tuff, volcanic breccia, lahar, and volcanic conglomerate and an upper member of massive feldspar phyric andesite to dacite flows. In places the lapilli tuffs are welded and may be ash flows. The succession is believed to overlie feldspar-pyroxene phyric andesite flows of the Upper Triassic Takla Group. It is uncertain whether the Wright Bay volcanics are an upper member of the Takla Group and therefore equivalent to the Moosevale Formation or a lower member of the Hazelton Group and correlative with the Telkwa Formation. A sample was collected from a massive feldspar phyric flow at Wright Bay for U-Pb isotopic dating.

A feature that distinguishes the Wright Bay succession from possible age equivalent rocks of the Telkwa Formation is the presence of 1 to 5 centimetre, subrounded to angular clasts of aphanitic pink and white weathering monzonite and flow-banded rhyolite clasts in a greenish grey crystal-ash matrix (Photo 4). The clasts are similar to phases of the Topley intrusions suggesting a comagmatic association. In one locality a pink-weathering, aphanitic Topley-like dike cuts flows of the upper member suggesting at least some Topley magmatism continued after the main phase of volcanic eruption. In places the pyroclastic rocks resemble the Nose Bay intrusive breccia which is located east of Wright Bay. This breccia, which was described in a previous report (MacIntyre *et al.*, 1996), may have been a feeder vent for the Wright Bay volcanic rocks. Similar breccias containing Topley clasts crop out south of Tachek Creek on the west side of Babine Lake, and these too may be related to the Wright Bay volcanic rocks. The latter were mapped as the Tachek Group by Armstrong (1949) and were thought to be Jurassic or younger. In a previous report it was suggested the Wright Bay volcanics might be as young as Eocene (MacIntyre *et al.*, 1998); additional mapping in 1998 suggests this is not the case. Although the Wright Bay succession is here included with the Hazelton Group, additional isotopic age dating may show that these rocks are older and more appropriately correlated with the upper part of the Takla Group.

Topley Intrusive Suite

The Topley intrusions, as defined by Carter (1981), include quartz diorite to quartz monzonite of Late Triassic to Early Jurassic age. Earlier studies (Carr, 1965; Kimura *et al.*, 1976) used the term Topley intrusions for granite, quartz monzonite, granodiorite, quartz diorite, diorite and gabbro intrusions of probable Jurassic age that intrude Triassic volcanic rocks from Babine Lake to Quesnel. Included in this Topley suite were high-potassium intrusions associated with the Endako porphyry molybdenum deposit. However, subsequent K-Ar isotopic dating showed most of these high-K intrusions were Late Jurassic to Early Cretaceous in age. Consequently, the intrusions around Endako were renamed the Francois Lake intrusions to distinguish them from the older Topley suite.

Potassium-argon isotopic dates for the Topley intrusions, as defined by Carter (1981), would include ages as young as 176 Ma and as old as 210 Ma (MacIntyre *et al.*, 1996). Initial dating of the Topley suite is from large plutons in the Topley area and southwest of Babine Lake. These plutons gave ages in the 190 to 210 Ma range using the K-Ar dating method. In the current study, the Topley intrusions are restricted to this Late Triassic to Early Jurassic suite which is characterized by typically pink, potassium feldspar rich granite, quartz monzonite and monzonite. A lithologically similar suite of predominantly Middle Jurassic (179-169 Ma) plutons occurs in the northwest Fort Fraser map area. These plutons are mapped as the Spike Peak intrusive suite. The Topley suite is restricted to older plutons in the type area near Topley Landing on Babine Lake. Within the current map area, it is represented only by poorly exposed granite to monzonite that crops out along the western edge of the area south of Babine Lake (Figure 2).

Spike Peak Intrusive Suite

The Spike Peak intrusive suite comprises Middle Jurassic plutons that include pink to red weathering granites and quartz monzonites that are lithologically identical to rocks that characterize the older Topley intrusive suite. The Middle Jurassic isotopic ages determined for the suite are similar to those determined for hornblende diorite of the Stag Lake-Twentysix Mile Lake plutonic suite in the Hallet Lake area (Anderson *et al.*, 1997). Within the Takla Lake - Babine Lake area, the Spike Peak suite is represented by a continuous belt of plutonic rocks that extends from the Takla Range, near Takla Landing, southward to Wright Bay on Babine Lake (Figure 2). These plutonic rocks intrude mainly the Takla Group, but locally cut the Hazelton Group or the Late Triassic Tochcha Lake pluton. The northern part of this composite pluton, which includes quartz monzonite, granite, hornblende diorite and biotite±hornblende granodiorite, was referred to as the Northwest Arm pluton by Schiarizza *et al.* (1998). Subsequent to that report, Mike Villeneuve of the Geological Survey of Canada has determined two U-Pb isotopic ages on zircons extracted from samples taken from this part of the pluton. These ages are 169.0 ±0.6 Ma for a hornblende diorite on the west flank of Mt. Blanchet, and 171.8 ±0.6 Ma for quartz monzonite that underlies Spike Peak, 4 km to the west. These ages are virtually identical to the 169.1 +1.0/-4.8 U-Pb zircon date reported by Schiarizza *et al.* (1998) for monzogranite of the smaller Takla Landing pluton, which crops out on either side of Takla Lake a short distance to the north. Farther south, just east of Tochcha Lake, hornblende from a hornblende diorite phase of the main pluton gave a 167.7 ±1.7 Ma Ar-Ar isotopic age. All of these ages are slightly younger than two other isotopic dates determined as part of the Babine project. Hornblende from a small hornblende feldspar porphyritic monzonite stock exposed in a clearcut west of Tochcha Lake gave an Ar-Ar isotopic age of 175.7 ±1.7 Ma. (MacIntyre *et al.*, 1996), and zircon extracted from a biotite granite phase east of Babine Lake gave a U-Pb isotopic age of 178.7 ±0.5 Ma. West of Babine Lake, at the Tachek Creek porphyry copper prospect, biotite from a biotite-quartz-feldspar porphyry dike was dated at 176 ±7 Ma (178 Ma revised) by the K-Ar method (Carter, 1981).

Sitlika Assemblage

The Sitlika assemblage comprises upper Paleozoic to lower Mesozoic metavolcanic and metasedimentary rocks that crop out in the western part of Cache Creek Terrane in central British Columbia. These rocks were first described by Paterson (1974) who mapped them on the east side of Takla Lake, where they had previously been included in the Cache Creek and Takla groups by Armstrong (1949). Monger *et al.* (1978) correlated the Sitlika assemblage with the Kutcho Formation, host to the Kutcho Creek volcanogenic massive sulphide deposit, which occurs in the eastern part of the King Salmon allochthon in northern British Columbia. They suggested that the Kutcho and Sitlika assemblages might have been contiguous prior to dispersion along Late Cretaceous or early Tertiary dextral strike-slip faults.

Schiarizza and Payie (1997) confirmed that the Sitlika assemblage resembles the Kutcho Formation and overlying metasedimentary rocks (Sinwa and Inklin formations) in general lithology and stratigraphy, while Childe and Schiarizza (1997) documented that volcanic rocks of the two assemblages are similar in age, geochemistry and Nd isotopic signature. Furthermore, Childe *et al.* (1997, 1998) and Schiarizza and Payie (1997) correlated the Kutcho-Sitlika succession with rocks in southern British Columbia, suggesting that the Sitlika assemblage is part of an extensive tract within or adjacent to Cache Creek Terrane that occurs over most of the length of the Canadian Cordillera.

Paterson (1974) divided the Sitlika assemblage into three subdivisions. A similar scheme was adopted by Schiarizza and Payie (1997), who referred to the subdivisions as the volcanic unit (equivalent to Paterson's volcanic division), the eastern clastic unit (equivalent to Paterson's greywacke division) and the western clastic unit (equivalent to Paterson's argillite division). Schiarizza and Payie established that the eastern clastic unit rests stratigraphically above the Permo-Triassic volcanic unit, but did not establish the age or stratigraphic relationships of the western clastic unit. Subsequent work by Schiarizza *et al.* (1998) traced the three units of the Sitlika assemblage to the south side of Takla Lake, but likewise did not resolve the stratigraphic affinity of the western clastic unit.

During the 1998 field season the Sitlika assemblage was traced southward to Babine

Lake, although continuity of the belt is broken by major transverse faults along Purvis Lake, Tildesley Creek and Trembleur Lake (Figure 2). As was the case to the north, it comprises rocks that had been included in the Cache Creek Group by Armstrong (1949). In addition, new mapping south of Takla Lake, together with visits to previously mapped outcrops to the north, has resulted in an improved understanding of the western clastic unit. Most of the unit is now interpreted as a structural repetition of the eastern clastic unit. Chert pebble conglomerate that dominates the western part of the unit where it was originally defined north of Takla Landing is interpreted as a fault-bounded panel derived from the Stikine Terrane (upper part of the Takla Group). Consequently, the Sitlika assemblage is now defined in terms of two components: a Permo-Triassic volcanic unit, and an overlying Upper Triassic - Lower Jurassic clastic sedimentary unit.

Volcanic Unit

The volcanic unit of the Sitlika assemblage is best exposed in a continuous belt that extends from Mount Olson southward to Takla Lake (Schiarizza and Payie, 1997; Schiarizza *et al.*, 1998). It comprises greenschist facies mafic to felsic flow and fragmental rocks, comagmatic mafic to felsic intrusions, and subordinate sedimentary rocks that include sandstone, slate and chert. The age of the volcanic unit is in part constrained by Late Permian U-Pb dates on zircons from two separate weakly foliated quartz-plagioclase-phyric rhyolite units that crop out north of the area shown in Figure 2. One, north of Mount Bodine, is dated at 258 +10/-1 Ma (Childe and Schiarizza, 1997), and the other, northeast of Diver Lake, yielded a date of 248.4 ±0.3 Ma (Mike Villeneuve, personal communication, 1998). These dates are corroborated by Permian radiolarians (*Latentibifistula* sp.) extracted from a narrow chert interval intercalated with the volcanic rocks south of Mount Olson (Fabrice Cordey, written communication, 1997). Magmatism within the Sitlika assemblage continued into the Early Triassic, as indicated by U-Pb zircon dates from two separate tonalite stocks within the volcanic unit. One, the Diver Lake pluton, yielded a date of 241 ±1 Ma (Childe and Schiarizza, 1997), while tonalite from the composite Maclaing Creek pluton (Schiarizza *et al.*, 1998; Figure 2) is dated at 243 ±3 Ma (Mike Villeneuve, personal communication, 1998).

Photo 5. Outcrop of dark grey, feldspar phyric metadacite or meta-andesite of the Sitlika volcanic unit exposed in road cuts south of Cunningham Lake, 93K/11 map sheet. Note flattened and stretched felsic clasts.

The Sitlika volcanic unit continues southward from Takla Lake as a narrow belt of chlorite schist that was traced to the Purvis Lake fault. It was not recognized within the offset continuation of the Sitlika belt south of the fault, but might be present under the belt of Quaternary cover along Gloyazikut Creek that separates exposures of the Sitlika clastic unit from Stikine Terrane to the west (MacIntyre *et al.*, 1998). South of the Tildesley Creek fault, pillowed metabasalts and chlorite schists that crop out directly west of the Sitlika clastic unit might represent the volcanic unit, but alternatively might be part of the North Arm succession of the Cache Creek Complex, which is widely exposed still farther west. More definitive exposures of the volcanic unit occur west of Cunningham Lake, in the offset extension of the Sitlika belt south of the Trembleur Lake fault system. These rocks define a belt that separates the Sitlika clastic unit from exposures of Stikine Terrane to the west.

The western part of the Cunningham Lake belt is dominated by felsic metavolcanic rocks, including weakly to moderately foliated feldspar-phyric metadacite with relict flow-banding, variably schistose quartz-feldspar-phyric metarhyolite, and chlorite-sericite schist containing flattened felsic clasts and quartz and feldspar grains (Photo 5). These rocks are locally cut by pre-metamorphic intrusive units that include granitoid gneiss, metadiorite and narrow dikes of chlorite-feldspar-amphibole schist. The eastern part of the unit consists mainly of epidote-chlorite schist and semischist, commonly with relict feldspar and pyroxene phenocrysts.

The metavolcanic rocks west of Cunningham Lake are readily assigned to the Sitlika volcanic unit on the basis of a characteristic suite of lithologies derived from felsic and mafic volcanic rocks, as well as felsic and mafic intrusive phases. The correlation is consistent with the position of the belt directly west of the Sitlika clastic unit, although the contact was not observed so it is not known if it is structural or stratigraphic. A felsic metavolcanic member of the succession was collected for U-Pb dating of zircons in an attempt to confirm the correlation.

Clastic Sedimentary Unit

The Sitlika clastic sedimentary unit consists of slate, siltstone, and sandstone, with local intercalations of conglomerate and limestone. It is locally well exposed within a continuous belt almost 100 km long that crops out east of the volcanic unit from Mount Olson southward to the Purvis Lake fault. The base of the unit is exposed at several places within this belt, where it is in abrupt, disconformable(?) stratigraphic contact with the underlying volcanic unit (Schiarizza and Payie, 1997; Schiarizza *et al.*, 1998). The clastic sedimentary unit also crops out to the west of the volcanic unit over this distance, where it is interpreted as a structural repetition localized along the fault contact with Stikine Terrane. The clastic unit is dated at a single locality, 3 km west of Tsayta Lake, where Late(?) Norian conodonts were extracted from a schistose calcarenite bed (M.J. Orchard, written communication 1998). Its age is suspected to extend from the Late Triassic into the Early Jurassic based on correlation with Lower Jurassic clastic sedimentary units that overlie Sitlika-correlative volcanic rocks in both northern and southern British Columbia (Schiarizza, 1998).

The clastic sedimentary unit crops out in three separate areas south of the Purvis Lake fault; these are inferred to be parts of a once-continuous belt offset by the Tildesley Creek and Trembleur Lake fault systems. This belt correlates with the eastern belt north of the Purvis Lake fault, based on its structural position directly west of the Cache Creek ultramafic unit and, at least locally, directly east of metavolcanic rocks correlated with the Sitlika volcanic unit (Figure 2). The contact with the volcanic unit was nowhere observed south of the Purvis Lake fault, but facing directions within the well-exposed northeast-dipping succession of clastic metasedimentary rocks west of Mount Sidney Williams are consistently to the east, as predicted by this interpretation.

Exposures of the Sitlika clastic unit between Takla and Babine lakes are dominated by a rather monotonous succession of thin-bedded, medium to dark grey slates, slaty siltstones and siltstones. Thin to thick beds of fine to coarse-grained sandstone are fairly common, and include schistose feldspar-lithic wackes as well as massive well-indurated quartz-rich arenites. Foliated pebble conglomerate was observed rarely in western exposures of the unit near Cunningham Lake; some conglomerate units contain mainly felsic volcanic clasts whereas others are dominated by flattened chert clasts. Foliated limestone is an important component of the succession between the Purvis Lake and Tildesley Creek faults (MacIntyre *et al.*, 1998), and also occurs locally in the western part of the succession north of Cunningham Lake. Thin to medium beds of grey chert were noted over a narrow stratigraphic interval at a single locality within the central part of the unit southwest of Mount Sidney Williams.

Most of the above lithologies are characteristic of the Sitlika clastic unit in its main exposure belt north of the Purvis Lake fault. The exception is the chert-clast conglomerates near Cunningham Lake which have not been observed elsewhere. Samples of chert and limestone collected from the 1998 field area have been submitted for microfossil extraction in an attempt to further constrain the age of the Sitlika clastic unit.

Cache Creek Complex

The Cache Creek Complex is an imbricated assemblage of upper Paleozoic and lower Mesozoic oceanic rocks. Within the Babine Lake - Takla Lake area it is subdivided into 4 major lithotectonic units. The western part of the complex includes the Trembleur ultramafic unit and the overlying North Arm succession, which are interpreted as mantle and crustal portions, respectively, of an ophiolite sequence. This ophiolite succession is in thrust contact above the clastic unit of the

Sitlika assemblage to the west. Faulted against the ophiolitic rocks to the east is a succession of pelagic metasedimentary rocks referred to as the phyllite-chert unit of the Cache Creek Complex. These rocks are in stratigraphic and/or fault contact with several thick limestone units that occur mainly along the eastern margin of the Cache Creek belt and comprise the fourth mappable unit within it.

Trembleur Ultramafic Unit

Ultramafic rocks within the Cache Creek belt were referred to as the Trembleur intrusions by Armstrong (1949), who interpreted them to be intrusive bodies cutting the Cache Creek sedimentary and volcanic rocks. Paterson (1974) recognized that the ultramafic rocks east of Mount Bodine comprised a major fault zone that separated the Cache Creek Group from the Sitlika assemblage. This faulted belt was traced by Schiarizza *et al.* (1998) into the southern Mitchell Range, where Armstrong's Trembleur intrusions had been interpreted by Elliot (1975) and Whittaker (1983) to be structurally emplaced alpine-type peridotites. Mapping to the south during the 1998 field season has documented that the apparently isolated ultramafic massifs at Mount Sidney Williams and Rubyrock Lake occupy the same structural position, thrust above the Sitlika clastic unit, as the ultramafic belt to the north (Figure 3). They are therefore inferred to be part of the same, once continuous belt, offset along the Tildesley Creek and Trembleur Lake fault systems. Furthermore, the identification of a sheeted dike complex as a component of the overlying North Arm succession corroborates earlier interpretations (Whittaker, 1983; Ash and Macdonald, 1993) that that the ultramafic rocks comprise part of an ophiolite succession.

The Trembleur ultramafic unit consists of variably serpentinized harzburgite, dunite and orthopyroxenite, together with zones of serpentinite, serpentinite melange, variably foliated carbonate-talc rocks and listwanite . The ultramafic rocks are intruded by dikes and pods of diabase, clinopyroxenite and gabbro, and locally contain fault slivers and tectonic inclusions of metavolcanic and metasedimentary rock.

Relatively unaltered ultramafic rocks were observed in parts of the northern and southern Mitchell Range, on Tsitsutl Mountain, on the Mount Sidney Williams ridge system and to the east and southeast of Rubyrock Lake. The dominant rock type is rusty-brown to grey-brown weathering harzburgite characterized by a warty texture resulting from resistant orthopyroxene grains standing in relief against a background of mainly serpentinized olivine. Layering is observed locally and is defined by bands of orthopyroxenite, 1 to 3 cm wide, separated by wider layers of typical harzburgite. Many harzburgite exposures exhibit a penetrative, locally mylonitic foliation that is inferred to be a mantle transport fabric. The foliation typically has a platy to ribbony aspect, and is defined by mm-scale bands dominated by flattened orthopyroxene grains interleaved with less resistant fine-grained olivine-rich bands. Although not mapped in detail, this ductile foliation is commonly at a high angle to the external contacts of the ultramafic unit, and in places is clearly cut by foliations defined mainly by talc or serpentine minerals that are parallel to the external contacts and are presumably related to the thrust imbrication of the ultramafic rocks with adjacent units.

Dunite, distinguished by its tan-weathering colour and smooth-textured surface, is commonly associated with the harzburgite as a volumetrically subordinate phase. It consists of serpentinized olivine accompanied by up to a few per cent chromite and, locally, rare grains of orthopyroxene. Dunite most commonly occurs as irregular pods and lenses within harzburgite that are typically several metres to tens of metres in size. Whittaker (1983) describes these in some detail, and also describes zones of interlayered dunite and harzburgite, as well as tabular dikes of dunite that emanate from large dunite pods and crosscut the tectonite fabric in the host harzburgite. He interprets these, and other features of the ultramafic rocks, as reflecting an origin in depleted mantle beneath an oceanic spreading centre, and suggests that the ultramafic rocks exposed in the Mitchell Range represent a deeper level than those at Mount Sidney Williams.

Large parts of the Trembleur ultramafic unit are altered to the extent that protolith compositions are not recognizable. Foliated serpentinite, locally passing into serpentine-magnesite-talc schist, commonly forms a zone several hundred metres wide along the structural base of the unit. Relatively narrow zones of similar rock occur throughout the unit, perhaps reflecting local shear zones. Listwanite likewise occurs as narrow, fault or fracture-controlled zones of alteration that are relatively widespread but generally do not comprise a major proportion of the unit. The largest alteration zone within the area consists of variably foliated carbonate-talc rocks that cover more than 50 square km to the east and southeast of Mount Sidney Williams (Figure 2). These rocks typically weather to an orange-rust colour, presumably reflecting an ankeritic component to the carbonate. Zones of more resistant listwanite occur locally within the unit, and a lens of pure talc was observed at one locality, covered by the Dial claim, about 7.5 km east-southeast of Mount Sidney Williams.

Diabase and microgabbro, in many places partially altered to rodingite, are relatively common as tabular to boudinaged dike-like bodies that intrude harzburgite and associated rocks of the ultramafic unit. Larger bodies of clinopyroxenite, gabbro and amphibolite also occur, but adjacent ultramafic rocks are typically sheared and/or serpentinized such that original relationships are not clear. These mafic intrusive rocks are typical of the North Arm succession and constitute part of the link connecting the mantle and crustal portions of the Cache Creek ophiolite sequence.

North Arm Succession

The North Arm succession, named for exposures along the North Arm of Stuart Lake, is characterized by diabasic to gabbroic intrusive rocks, but also includes significant proportions of mafic metavolcanic rock and metasedimentary rocks. This unit is widespread in the western part of the Cache Creek belt south of the Purvis Lake fault. It typically occurs structurally above the Trembleur ultramafic unit, where it is inferred to have originated as the upper part of an ophiolite sequence. Fault panels of the North Arm succession also occur to the west of and structurally beneath the ultramafic unit, where they are inferred to comprise structural repetitions resulting from both west directed imbrication of Cache Creek Terrane and later faulting (Figure 3).

The base of the North Arm succession comprises an igneous complex dominated by gabbroic to dioritic rocks. These rocks occur directly above the ultramafic unit at Rubyrock Lake, and are repeated along the structural base of the unit

Photo 6. Foliated gabbro and amphibolite from intrusive complex within the North Arm succession, south of Mt. Sidney Williams.

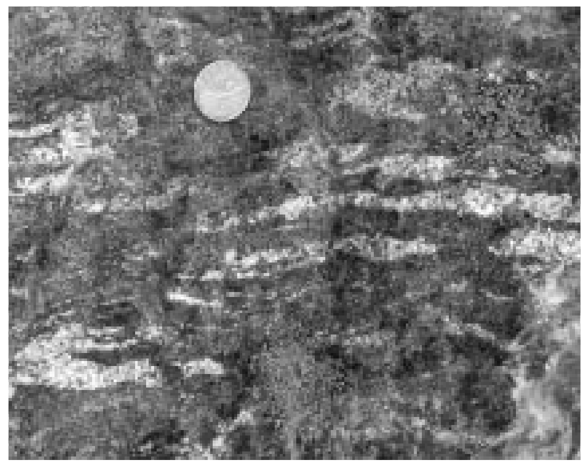

Photo 7. Tonalite lenses within gabbro/diorite intrusive complex of the North Arm succession, west of Mt. Sidney Williams.

Photo 8. Sheeted dike complex, east of Rubyrock Lake.

between Trembleur and McKelvey lakes, where they rest structurally above the phyllite-chert unit across a west-dipping fault (Figure 3, Section D). Similar rocks are also exposed south and west of Mount Sidney Williams, within the imbricate fault sliver structurally beneath the ultramafic unit (Figure 2). This igneous complex is dominated by isotropic to weakly foliated gabbro and diorite, but locally includes strongly foliated diorite and amphibolite localized along high strain zones of variable orientation (Photo 6). The complex also includes diabase and hornblende-feldspar porphyry dikes, as well as local dikes and pods of tonalite. Tonalite is most common in exposures west of Mount Sidney Williams (Photo 7). A sample collected from this area is being processed for zircon extraction, in an attempt to date the crystallization of the unit by the U-Pb method.

The basal part of the North Arm succession also includes a sequence of sheeted diabase dikes that are well exposed on a prominent ridge 6 km east of Rubyrock Lake. Individual dikes vary from a few cm to about 1 m in thickness and display uniform, steep northeast dips. Most dikes are chilled against an older dike to the east, and are intruded by a younger dike to the west (Photo 8). The opposite relationship occurs locally, however, and some dikes display chilled margins along both contacts. Elsewhere dike contacts are obscure or sheared across intervals of several metres. The average width and uniform dip of individual dikes, combined with the across-strike exposure width of the ridge, indicates that the complex includes many hundreds to thousands of individual dikes. They resemble diabase dikes and dike-boudins that cut the underlying Trembleur ultramafic unit, as well as dikes that occur at higher structural levels within the North Arm succession. They provide a link between the Trembleur ultramafic unit and the overlying North Arm succession, and provide compelling evidence for postulating an ophiolitic origin for the sequence.

The main part of the North Arm succession, which appears to reside structurally above the plutonic and dike complexes described above (Figure 3, Section D) consists of submarine mafic metavolcanic and metasedimentary rocks cut by numerous dikes and sills of greenstone, diabase and microdiorite. These rocks are well exposed on the shores of Trembleur Lake and on the alpine ridges east of Tsitsutl Mountain.

The rocks exposed along the shores of

Photo 9 Chert-clast conglomerate interbedded with massive greenstone and pillowed flows, north shore Trembleur Lake. Disruption of chert beds may be related to emplacement of dikes into unlithified sediments during periods of active volcanism.

Trembleur Lake are predominantly mafic pillowed flows, pillow breccia and chlorite schist. In general pillowed flows are found in the central and eastern parts of the belt while chlorite schists predominate to the west. Although the chlorite is in part the result of regional greenschist facies metamorphism, some chloritization may have resulted from submarine hydrothermal activity. Evidence for the latter are zones of quartz-carbonate veining and disseminated pyrite associated with strong chlorite and epidote alteration. Marine sedimentary rocks comprise approximately 10 percent of the succession and are present as 10 to 50 metre-thick intervals of well bedded chert, cherty argillite, graphitic phyllite, argillaceous limestone and, in places, conglomerates or debris flows comprised of angular, rip-up clasts of chert and siltstone (Photo 9). Lithologically, these sediments resemble those of the phyllite-chert unit to the east. The volcanic and sedimentary rocks are intruded by numerous aphanitic greenstone dikes and sills which comprise 25 to 30 percent of the outcrop on the south shore of Trembleur Lake. These intrusions, which are compositionally similar to pillowed flows in the section, are massive, blocky weathering and form prominent headlands. Sediments near the contacts of these intrusions display chaotic fold patterns with many individual beds attenuated and dismembered. This implies that the dikes and sills, which are most likely feeders to flows higher up in the succession, cut through and deformed relatively unconsolidated marine sediments.

Other belts assigned to the North Arm succession are generally similar to the Trembleur Lake section, and are distinct from the phyllite-chert unit in the predominance of mafic volcanic and intrusive rocks over associated sedimentary intervals. In places, such as to the east of Fleming Lake and south of the west end of Trembleur Lake, massive greenstone, locally grading to fine-grained diabase or microdiorite is the predominant rock type over many square km, and associated metasedimentary rocks are restricted to narrow screens and xenoliths. Serpentinized ultramafic rocks are locally an important component of western exposures of the unit, where it is inferred to be imbricated along the base of the Trembleur ultramafic unit. These serpentinite lenses may actually be fault slivers derived from the overlying unit that are structurally interleaved with the North Arm succession.

The age of the North Arm succession is not well known. The only definitive fossil locality is on the east flank of Tsitsutl Mountain where a limestone bed interbedded with chlorite schists and greenstones has yielded Early(?) Triassic conodonts (M.J. Orchard, written communication, 1998). Two narrow limestone beds within the succession, one near the west end of Trembleur Lake and the other north of Fleming Lake, contain crinoid debris and fusulinids, suggesting that part of the succession is Late Paleozoic. Samples from these and other limestone units within the succession are currently being processed for conodonts in an attempt to better constrain its age.

The North Arm succession is interpreted as the upper part of an ophiolite sequence, generated in an oceanic spreading centre. The available age data, although sparse, suggest that sedimentary intervals intercalated with and intruded by the mafic volcanic and intrusive rocks related to this spreading event are Late Paleozoic and Early Triassic. This same age range is represented by volcanic and intrusive rocks of the Sitlika assemblage, which may represent an intraoceanic volcanic arc. This apparent coincidence of ages, coupled with their present spatial juxtaposition, suggests that the Trembleur ultramafic unit and overlying North Arm succession may have formed in a back-arc spreading centre behind the Sitlika arc. This interpretation predicts that the pending U-Pb zircon date from tonalite of the North Arm succession will be Late Permian or Early Triassic. Another implication of the inferred geologic environment of the North Arm succession (regardless of its age or relationship to the Sitlika assemblage) is that it presents an exploration target for volcanogenic massive sulphide deposits of the Besshi and Cyprus subtypes.

Phyllite-Chert Unit

Quartz phyllite, chert and associated metasedimentary rocks that crop out directly east of the Cache Creek ophiolitic sequence are assigned the phyllite-chert unit. These rocks are equivalent to the Cache Creek sedimentary unit of Schiarizza *et al.* (1998), and are at least in part equivalent to the Sowchea succession of Struik and Orchard (1998).

The phyllite-chert unit consists mainly of light to dark grey platy quartz phyllites that consist of plates and lenses of fine-grained recrystallized granular quartz, typically a centimetre or less thick, separated by phyllitic mica-rich partings. Associated with the phyllites are intervals of less recrystallized, light to medium grey or green chert that occurs as beds and lenses, from 1 to 5 centimetres thick, separated by phyllitic partings. Locally the platy phyllites and cherts are intercalated with less siliceous and more homogeneous medium to dark grey phyllites or slates.

Light to dark grey recrystallized limestone is locally intercalated or structurally interleaved with the siliceous metasedimentary rocks, and occurs as units ranging from a few metres to more than 100 metres thick. Some of these are sufficiently large to be mapped as separate units on Figure 2. Mafic metavolcanic rocks, including chlorite schist, pillowed greenstone and fragmental greenstone, occur rarely. They form lenses, ranging from a few metres to tens of metres thick, parallel to the synmetamorphic foliation and transposed compositional layering in surrounding metasedimentary intervals. Locally they are associated with weakly foliated, fine-grained chlorite-feldspar semischists that were probably derived from mafic dikes or sills.

The phyllite-chert unit rests structurally above the Trembleur ultramafic unit north of the Purvis Lake fault (Figure 3, Sections A and B). The contact was not observed in this area, but is inferred to be an east-directed thrust fault based on observations made along the same contact farther north (Schiarizza and Payie, 1997). A similar relationship is suspected for the contact between the phyllite-chert unit and structurally underlying North Arm succession between the Purvis Lake and Trembleur Lake faults, but the contact is obscured by the Pyramid Peak pluton in the north, and by Quaternary alluvium along the Middle River valley in the south. South of Trembleur Lake, the phyllite-chert unit rests structurally beneath the North Arm succession across an inferred west-dipping thrust fault (Figure 3, Section D). A similar relationship is documented farther south, near Shass Mountain, where Struik and Orchard (1998) show ultramafic and mafic rocks thrust above the Sowchea succession across a west-dipping thrust fault.

Samples from a limestone breccia within the phyllite-chert unit north of the present map area contained both Early and Middle Triassic conodonts (M.J. Orchard, written communication, 1997), whereas a limestone lens northeast of Purvis Lake yielded conodonts of Pennsylvanian or Permian age (M.J. Orchard, written communication, 1998). Other age constraints come from south of the present map area, where correlative rocks of the Sowchea succession have yielded Late Permian and Middle and Late Triassic radiolaria and conodonts (Struik and Orchard, 1998). Radiolarians of possible Early Jurassic age occur within the succession southwest of Stuart Lake, and a collection of radiolaria that has been assigned a definite Early Jurassic (Pliensbachian) age was extracted from a potentially correlative chert succession in the Prince George map area (Cordey and Struik, 1996).

Limestone

Massive to well-bedded, light grey-weathered limestone forms several mappable units within and east of the phyllite-chert unit north of Trembleur Lake. The most extensive belt, best represented by exposures around Kazchek and Kloch mountains near the eastern boundary of the map area, is up to 5 km wide and has been traced northward and southeastward from the present map area for a total strike length of about 100 km (Armstrong, 1949). Near Takatoot and Kloch lakes this limestone unit is juxtaposed directly against Quesnel Terrane across the Pinchi fault. To the north, however, it is separated from Quesnel Terrane by panels of serpentinite-gabbro-greenstone and limestone that are inferred to be slivers of Cache Creek rocks caught up in the Pinchi fault zone (Figure 2; Bellefontaine *et al.*, 1995). To the southeast of the present map area it is likewise separated from Quesnel Terrane by a northward-tapering fault panel of Upper Triassic - Lower Jurassic greywacke and basalt tuff that Struik and Orchard (1998) assign to the Tezzeron succession of the Cache Creek Group.

The Kazchek Mountain limestone unit dips mainly to the west or southwest, although local dip reversals provide evidence for some internal folding. The limestone belt includes rare exposures of chert, phyllite and fine-grained intrusive or extrusive mafic rock, but it is not clear if these rocks form part of the unit or are fault slivers derived from the adjacent phyllite-chert unit. Despite the possibility of internal structural repetitions, local well-exposed homoclinal sections indicate a minimum stratigraphic thickness of almost 1000 m. A sample from the central part of the Kazchek Mountain limestone unit, collected 3 km north of the west end of Tchentlo Lake in 1997, yielded Bashkirian - Moscovian (Late Carboniferous) conodonts (M.J. Orchard, written communication, 1998). Conodonts and macrofossils of the same age are reported from the eastern part of the unit both north and south of Kloch Lake (Orchard *et al.*, 1998, Samples N3-3 and K14-3). Samples collected from the western part of the unit farther to the south and southeast also yielded conodonts of the same, Late Carboniferous age (Orchard *et al.*, 1998, Samples K14-1, K15-3, K15-4, K15-5). These age data, together with its thickness and location near the eastern edge of the Cache Creek belt, indicate correlation of the Kazchek Mountain limestone unit with the Mount Pope limestone unit of the Fort St. James area (Sano and Struik, 1997; Orchard *et al.*, 1998), which is, at least in part, in thrust contact with metasedimentary rocks that may correlate with the phyllite-chert unit of the present study area (Struik and Orchard, 1998). Within the present map area, the western contact of the Kazchek Mountain limestone unit is not well exposed, but appears to dip steeply. It is suspected to be a steep fault, possibly related to the Pinchi fault system.

Other mappable limestone units within the eastern part of the Cache Creek belt are, at least in map view, enclosed within the phyllite-chert unit. The most extensive of these units is well exposed on Mount Copley, north of eastern Trembleur Lake. It has been traced for 25 km to the northwest (Figure 2) and continues southeastward beyond the map area for a total strike length of about 35 km (Armstrong, 1949). Exposures on the north flank of Mount Copley, as well as those near the northern end of the belt west of Kloch Lake, suggest that the Mount Copley limestone unit occupies the core of an anticline (Figure 3, Section C). Conodonts from within the unit west of Kloch Lake are Late Permian (Orchard *et al.*, 1998, Sample N3-1), whereas a suite of samples from the gradational contact with the overlying phyllite-chert unit to the east yield Late Permian and Early Triassic conodonts (Orchard *et al.*, 1998, Samples N3-2). These dates are within the range of ages established for the phyllite-chert unit regionally, suggesting that the Mount Copley unit represents a carbonate facies within it. Other mappable limestone bodies within the phyllite-chert unit to the west and northwest might be fold or fault repetitions of the Mount Copley unit (e.g. Figure 3, Section C), or might be separate carbonate lenses. Samples collected during the 1998 field season are currently being processed for conodonts in an attempt to establish their ages.

Late Middle Jurassic to Early Cretaceous Intrusions

Middle Jurassic granitoid plutons within Stikine Terrane were described in a previous section. A number of other map-scale plutons occur within the area, where they intrude the Cache Creek Complex and Sitlika assemblage. Most are undated, but at least three temporally distinct magmatic events are represented by the plutons with known ages. These include the late Middle Jurassic McKnab Lake pluton, Late Jurassic to Early Cretaceous stocks at the Mac porphyry molybdenum prospect, and the Early Cretaceous Mitchell batholith. The McKnab Lake pluton is coeval with or slightly younger than Middle Jurassic plutons within the adjacent Stikine Terrane, and the composite Endako batholith, within Stikine Terrane to the south-southeast, includes Middle Jurassic to mid-Cretaceous plutonic suites that apparently correlate with the plutons described here. These plutons are therefore inferred to comprise part of a Middle Jurassic and younger magmatic belt that overlaps the contact between the previously amalgamated Stikine and Cache Creek terranes.

In the summary that follows undated plutons are described immediately following the dated pluton to which they bear the closest lithological resemblance.

Middle Jurassic McKnab Lake Pluton

Tonalite, quartz diorite and diorite in the southeastern part of the map area comprise the west end of the McKnab Lake pluton, a large east to southeast-trending plutonic body that extends for an additional 40 km beyond the southeastern boundary of the study area (Struik, 1998). It was referred to as the Shass Mountain pluton by Ash and Macdonald (1993), but Letwin and Struik (1997) introduced the new name because detailed mapping had shown that, contrary to the map of Armstrong (1949), Shass Mountain itself was underlain by imbricated rocks of the Cache Creek Group.

Within the present study area, the McKnab Lake pluton is predominantly medium to coarse-grained hornblende-biotite quartz diorite and tonalite. Diorite occurs locally along the northern margin of the pluton, and also occurs as xenoliths within the quartz-bearing phases. The predominant quartz-bearing phases range from isotropic to moderately foliated. Foliation is commonly parallel to the pluton contact and is accentuated by flattened xenoliths of foliated diorite and amphibolite.

The McKnab Lake pluton is assigned a late Middle Jurassic age based on a U-Pb zircon date of 165 +2/-1 Ma reported by Ash *et al.* (1993) from west of southern Stuart Lake, almost 35 km east-southeast of the southeastern corner of the present map area. A sample collected in 1998 from near the western margin of the pluton, south of Cunningham Lake, has been submitted for U-Pb dating to test for uniformity of age in this large plutonic body. This date will help constrain the age of the fault contact between the Trembleur ultramafic unit and the Sitlika clastic unit, which is truncated by the pluton at Cunningham Lake (Figure 2).

McKelvey Lake Pluton

The McKelvey Lake pluton intrudes the North Arm succession and phyllite-chert unit of the Cache Creek Complex between Stuart and

Trembleur lakes. It was examined by Ash and Macdonald (1993) and Hrudey and Struik (1998), who describe it as biotite quartz diorite, diorite and tonalite, and suggest that it correlates with the McKnab Lake pluton.

Fleming Lake Stock

Relatively resistant exposures of hornblende diorite, locally cut by tonalite or granodiorite phases, define a stock measuring about 4 by 5 km to the west-northwest of Fleming Lake. On its eastern margin the stock intrudes, and locally contains xenoliths of, metachert, greenstone and actinolite-epidote-feldspar semischist assigned to the North Arm succession of the Cache Creek Complex. The country rock adjacent to the eastern part of the stock is not exposed. The Fleming Lake stock is not dated, but is suspected to be Middle Jurassic in age.

Embryo Lake Pluton and Purvis Lake Stock

The Embryo Lake pluton consists of medium-grained, isotropic to weakly foliated ±biotite-hornblende quartz diorite, tonalite and diorite. It forms prominent exposures northeast of the southern tip of Takla Lake, where it intrudes the phyllite-chert unit of the Cache Creek Complex. The northwestern contact of the pluton is inferred to be the Purvis Lake fault, across which it is juxtaposed against granodiorite of the Leo Creek stock (Figure 2). The Embryo Lake pluton is distinguished from the Early Cretaceous(?) Leo Creek stock, as well as from the adjacent Pyramid Peak and MacDonald Lake plutons by the general absence of potassium feldspar and the presence of hornblende as the predominant mafic phase. It is lithologically very similar to the Middle Jurassic McKnab Lake pluton, with which it is tentatively correlated.

The Purvis Lake stock, which intrudes the Cache Creek phyllite-chert unit on the northwest side of the Purvis Lake fault, 5 km northeast of the Embryo Lake pluton, is likewise inferred to be Middle Jurassic in age. It consists mainly of medium-grained, equigranular hornblende diorite to quartz diorite, but also includes clinopyroxenite and gabbro, which are locally common as xenoliths and screens within the diorite (Schiarizza *et al.*, 1998).

Late Jurassic - Early Cretaceous Francois Lake Plutonic Suite

At the Mac property near Tildesley Creek, small granitoid stocks and dikes, some with associated molybdenum mineralization, intrude mafic metavolcanic rocks and serpentinite assigned to the North Arm succession of the Cache Creek Complex. The largest plutonic body is an unmineralized stock of medium-grained biotite granodiorite that crops out west and southwest of the main mineralized zones. Biotite from this stock has been dated at 141 ±5 Ma by the K-Ar method (Godwin and Cann, 1985). Godwin and Cann also report a K-Ar date of 136 ±5 Ma on biotite from altered leucocratic granite of the mineralized Camp zone stock (Cope and Spence, 1995). More recently, an Ar-Ar date of 142.5 ±1.4 Ma was obtained on biotite from a sample of drill core from the same stock (MacIntyre *et al.*, 1997, Table 1). These dates are slightly younger than new 145-148 Ma Ar-Ar isotopic ages determined for the younger subsuite of the Francois Lake plutonic suite, which hosts molybdenum mineralization in the Endako batholith (Anderson *et al.*, 1998).

Early Cretaceous Mitchell Batholith

The Mitchell batholith occupies the core of the Mitchell Range, where it intrudes the sedimentary unit of the Sitlika assemblage, as well as the ultramafic and phyllite-chert units of the Cache Creek Complex (Schiarizza *et al.*, 1998). The northern part of the batholith is dominated by K-feldspar megacrystic, ± hornblende-biotite monzogranite, locally accompanied by an older border phase of mafic-rich biotite-hornblende quartz diorite to diorite along it east-central and northwestern margins. The southern part of the batholith is mainly medium to coarse-grained ±muscovite-biotite granodiorite, locally intruded by thick dikes of quartz-feldspar porphyry.

Zircons extracted from K-feldspar megacrystic monzogranite of the Mitchell batholith, sampled 2 km south of Sawtooth Mountain, yielded a U-Pb date of 121.9 ±0.1 Ma (Mike Villeneuve, personal communication, 1998). This is apparently a unique crystallization age for major plutons in the region, although it is not a great deal older than the 90 to 115 Ma Fraser Lake plutonic suite that is represented by stocks of biotite monzogranite and granodiorite that occur locally along the margins of the composite Endako batholith (Anderson *et al.*, 1998). This date from the Mitchell batholith places some constraints on the age of the east-dipping thrust fault that places the Trembleur ultramafic unit above the Sitlika clastic unit, as this fault is truncated by the batholith (Figure 2).

Leo Creek Stock

The Leo Creek stock consists of medium to coarse-grained ± muscovite-biotite granodiorite that is exposed along the lower reaches of Leo Creek, on the northeast side of southern Takla Lake. It intrudes various units of the Cache Creek Complex and Sitlika assemblage to the north and west, and is inferred to be truncated by the Purvis Lake fault to the southeast. The Leo Creek stock resembles granodiorite that comprises the southern part of the Mitchell batholith, just 3 km to the north, and is presumed to be the same age.

Pyramid Peak Pluton

The Pyramid Peak pluton, named and described by MacIntyre *et al.* (1998), comprises biotite granodiorite that underlies the prominent peaks and ridges southwest of the southern end of Takla Lake (Figure 2). The pluton intrudes the North Arm succession of the Cache Creek Complex on the west, and the phyllite-chert unit to the east. It is truncated by the Purvis Lake fault to the north, and its southern margin is apparently defined by the Tildesley Creek fault. The age of the Pyramid Peak pluton is presently unknown, but samples have been submitted for U-Pb and Ar-Ar radiometric dating. It is here provisionally correlated with the Early Cretaceous Mitchell batholith and Leo Creek stock. In fact, it moves to a position directly opposite the Leo Creek stock when 7 to 8 km of dextral offset are restored on the Purvis Lake fault, suggesting that these two bodies represent offset portions of a single pluton.

Small plugs and dikes of white to pink weathering quartz-feldspar porphyry intrude the Cache Creek Complex on the ridge southeast of Tsitsutl Mountain, 2 to 3 km west of the Pyramid Peak pluton. The stocks are enclosed by a zone of disseminated pyrite within hornfelsed metavolcanic and metasedimentary country rocks of the Cache Creek Complex. These porphyry bodies may correlate with the thick dikes of quartz-feldspar porphyry that intrude granodiorite of the southern Mitchell batholith.

MacDonald Lake Pluton

The MacDonald Lake pluton intrudes the phyllite-chert unit of the Cache Creek Complex to the east and southeast of Purvis Lake. It and the adjacent Embryo Lake pluton were mapped as a single body by Armstrong (1949), but more detailed mapping shows that they are separated by 3 to 4 km of Cache Creek metasedimentary rocks. Furthermore, the MacDonald Lake pluton consists mainly of medium to coarse-grained, isotropic, biotite tonalite and granodiorite, in contrast to the hornblende-rich, locally foliated quartz diorite of the Embryo Lake pluton. Based on these lithologic attributes, the MacDonald Lake pluton is provisionally correlated with the Early Cretaceous Mitchell batholith.

Cretaceous Sedimentary Rocks

Sustut Group

The Sustut Group (Lord, 1948; Eisbacher, 1974) includes Cretaceous and Tertiary non-marine clastic rocks that overlap rocks of the Stikine Terrane and the Bowser Lake Group. The areal distribution of these rocks defines the northwest trending Sustut Basin which extends from the Stikine River in the northwest to Takla Lake in the southeast. The Sustut Group is restricted to the northwest corner of the present map area, where it is represented by exposures of conglomerate, sandstone and shale of the Tango Creek Formation. These rocks, which crop out west of the Takla fault, were mapped in 1997 and are described by MacIntyre (1998) and Schiarizza *et al.* (1998). They were not revisited during the 1998 field season.

Tertiary Volcanic Rocks

A gently southeast dipping section of Tertiary volcanic rocks is preserved in a down-dropped fault block that underlies a low-lying region in the central part of the 93K/12 map sheet. The western limit of these volcanics is an angular unconformity with Takla and Asitka Group rocks. The succession thickens eastward until it is truncated by a northeast-trending high angle fault that bounds an uplifted fault block. Outliers of Tertiary volcanics cap uplifted areas south of Tochcha Lake and north of Rubyrock Lake (Figure 2). Where exposed, the basal members of the succession are brown to dark grey vesicular and amygdaloidal basalt flows with local beds of basalt clast pebble conglomerate. The vesicles range from 1 to 10 millimetres in diameter and comprise 20 to 35 percent of the rock. Vesicles and amygdules are often flattened parallel to the flow direction. Individual flows are 5 to 15 metres thick and are separated by thin beds of volcaniclastic material Coarse debris flows or lahars comprised of vesicular and aphanitic basalt or andesite clasts up to 2 metres in diameter are locally interbedded with the flows. These rocks, which crop out sporadically through the central part of the 93K/12 map sheet and along the shores of Babine Lake (Figure 2), form a relatively thick unit. The best exposures are opposite Pendleton Bay where beautifully columnar jointed basalt flows are overlain by a thick debris flow unit containing clasts up to 4 metres in diameter.

Grey to pinkish grey weathering, hornblende-biotite-feldspar phyric to aphyric rhyodacitic ash flows, with lesser, thin, andesite and brown weathering basalt flows crop out as a series of knolls along the southern edge of the Tochcha Lake map sheet. The ash flows locally contain 5-10 percent hornblende and biotite phenocrysts that are up to one centimetre in diameter. Granitic inclusions are also common in some cooling units. Outcrops to the south and at lower elevation are aphanitic, dark grey basalt, feldspar phyric andesite and vesicular basalt. These rocks are interpreted to lie below the ash flow succession; alternatively they are separated by a high angle fault. Above the ash flow succession is a dark grey, aphanitic basalt flow that has a subconchoidal fracture. A sample of ash flow with fresh hornblende and biotite was collected for Ar-Ar isotopic dating in 1997; additional samples were collected by Nancy Grainger of the GSC in 1998.

Dark grey and red mudstones crop out near the eastern limit of Tertiary volcanic cover. Because the Tertiary succession is interpreted to thicken eastward as a wedge, these sediments are believed to be relatively high in the volcanic stratigraphy.

Photo 10. Flat-lying, Tertiary debris flow overlying ultramafic rocks north of Rubyrock Lake, 93K/11 map sheet. The debris flow contains feldspar phyric andesite boulders up to 2 metres in diameter.

The ridge north of Rubyrock Lake, in the 93K/11 map sheet, is also capped by Tertiary volcanic rocks. Here, hornblende-feldspar phyric dacite flows overlie serpentinized ultramafic rocks. The highest member in the Tertiary succession is a flat lying debris flow containing feldspar phyric andesite clasts up to 2 metres in diameter (Photo 10).

The age of the Tertiary volcanic cover in the southwest corner of the study area is unknown but presumed to be Eocene based on the ages of similar rocks elsewhere in central B.C. Hornblende-biotite phyric rhyolite to rhyodacite flows that crop out south of Tochcha Lake and north of Rubyrock lake are tentatively correlated with the Ootsa Lake Group, as are vesicular basalts, feldspar phyric andesites and aphanitic basalts that apparently underlie these rocks. Basaltic flows that overlie rhyodacite are correlated with the Endako Group based on lithology and stratigraphic position.

Eocene Intrusions

A distinctive suite of potassium feldspar megacrystic quartz monzonite or granite dikes cut Sitlika volcanic rocks along the crest of the ridge northwest of Cunningham Lake in the 93K/12 and 11 map sheets. These dikes, which are up to 100 metres thick, are characterized by a megacrystic texture defined by the presence of 25 to 30 percent, 1 to 2 centimetre, equant potassium feldspar phenocrysts. In addition these rocks contain 5 to 10 percent, 1 to 2 millimetre hornblende and/or biotite and 5 to 10 percent, 2 to 4 millimetre quartz phenocrysts, all in a pinkish grey quartz-feldspar groundmass. Biotite extracted from one of these dikes on the Ascot Resources Fort property gave an Ar-Ar isotopic age of 52 Ma, suggesting this suite of intrusions is Eocene in age. This age is similar to those determined for the Babine Intrusions in the Babine Porphyry Belt (Villeneuve and MacIntyre, 1997) located west of the project area. On the northern part of the Fort property, emplacement of the dikes produced a broad zone of biotite hornfels that typically contains 1 to 5 percent disseminated pyrite

Finer-grained, crowded biotite-hornblende-feldspar and biotite-quartz-feldspar porphyritic granodiorite dikes that are lithologically similar to the Eocene Babine Intrusions also occur in the Cunningham Lake area. These dikes intrude the pyroxenite-gabbro-diorite complex at the Fort prospect. A similar suite of dikes intrudes serpentinite along the crest of the ridge north of Rubyrock Creek in the 93K/11 map sheet and one of these has porphyry copper style sulphide mineralization associated with it.

STRUCTURE

The Babine Lake - Takla Lake area is comprised of two main structural domains. The eastern domain includes penetratively deformed, greenschist facies rocks of the Cache Creek Complex and Sitlika assemblage, arranged as a series of linear, north to northwest trending fault panels that apparently originated as east-dipping thrust slices in Middle Jurassic time. The western domain is underlain by the various stratigraphic and plutonic components of Stikine Terrane. Only some of these rocks display penetrative fabrics, and east-dipping thrust faults are only locally preserved. Regional relationships suggest, however, that Stikine Terrane formed the footwall to the west-directed thrust system within adjacent Cache Creek Terrane.

Younger structures within the map area include steep, north to northwest-striking faults, many of which formed during a period of orogen-parallel dextral strike-slip in Late Cretaceous - Early Tertiary time. Other prominent structures are northeast-striking faults, most with apparent dextral displacements, that locally offset the northerly trending fault panels. The most significant of these structures are the Purvis Lake, Tildesley Creek and Trembleur Lake fault systems. The northeast-striking faults may be coeval with, or younger than, the northwest-striking dextral strike-slip faults.

Sitlika - Cache Creek Belt

Mesoscopic Fabrics

Both units of the Sitlika assemblage are characterized by a single penetrative cleavage or schistosity defined by the preferred orientation of greenschist facies metamorphic minerals and variably flattened clastic grains or volcanic fragments. The cleavage dips steeply to the east or east-northeast through most parts of the Sitlika belt, although steep westerly dips prevail locally. It is axial planar to upright folds of bedding, most commonly observed in well-bedded metasedimentary rocks of the Triassic-Jurassic clastic unit, with axes that plunge north-northwest or south-southeast. Younger folds and crenulations with similarly oriented axes deform the cleavage locally, as do rare east or west plunging kink folds and crenulations.

Most of the Cache Creek Complex comprises greenschist facies rocks that are of comparable metamorphic grade to the Sitlika assemblage, but contrast markedly in structural style (Paterson, 1974; Wright, 1997; Schiarizza *et al.*, 1998). Mesoscopic structures are best displayed in the phyllite-chert unit and metasedimentary intervals of the North Arm succession, where compositional layering has been transposed into parallelism with a prominent metamorphic foliation. This foliation dips at moderate to steep angles to the east or northeast throughout most of the area, but dips are mainly to the west or southwest south of the Trembleur Lake fault system. The foliation is axial planar to fold hinges defined by thin chert beds, but these were observed only locally and are quite variable in orientation. The primary foliation and transposed bedding within the Cache Creek metasedimentary intervals are commonly deformed by younger structures, represented mainly by a set of east-verging folds with moderately west-dipping axial surfaces, generally marked by a crenulation or fracture cleavage. The axes of these folds, along with associated crenulation lineations, typically plunge to the northwest or south. Metamorphic minerals that define the first generation schistosity are, at least in part, bent and kinked by these younger structures, indicating that these folds postdated most of the metamorphism.

Mesoscopic fabrics that apparently predate those described above occur locally within specific units of the Trembleur ultramafic unit and North Arm succession. These include the ductile, locally mylonitic foliations within harzburgite that are inferred to be mantle transport fabrics, as well as variably oriented zones of plastic deformation that were observed within gabbro-diorite plutonic complexes of the North Arm succession. The latter fabrics may have been localized along high strain zones associated with plutonism during construction of oceanic crust in a spreading centre environment.

Macroscopic Structure

The Cache Creek and Sitlika assemblages comprise a regular arrangement of fault-bounded panels that has been traced from Ogden Mountain southward to Cunningham Lake, a distance of 150 km (Schiarizza and Payie, 1997; Schiarizza *et al.*, 1998; Figure 2). The easterly dips that prevail in most of the belt are presumed to reflect the primary assembly of the sheets by way of west-directed thrusting. The east-dipping thrust sequence comprises 3 main levels which are, in ascending order, the Sitlika assemblage, ophiolitic rocks of the Cache Creek Complex, and sedimentary rocks of the Cache Creek Complex (Figure 3, Sections A, B and C). It is suspected that this stacking was broadly coeval with greenschist facies metamorphism and the development of penetrative fabrics within both the Sitlika assemblage and the Cache Creek Complex. South of the Trembleur Lake fault system, however, dips are mainly to the west and the apparent stacking order is, at least locally, reversed. This is presumed to reflect the influence of second generation east-directed folds and thrust faults, which are prominent mesoscopic features of the Cache Creek rocks in this part of the belt (Figure 3, Section D). Alternatively, or in addition, there may be a component of down-to-the-east tilting of this panel, perhaps related to movement along the Trembleur Lake fault system.

The Sitlika assemblage comprises, for the most part, an east-dipping and facing succession in which the volcanic unit lies to the west of the overlying clastic sedimentary unit. North of the Purvis Lake fault, however, the clastic sedimentary unit also occurs as a narrow panel to the west of the volcanic unit. This repetition may be the result of west-directed thrust-imbrication, coeval with synmetamorphic folding within the Sitlika succession and stacking of Cache Creek Complex above the Sitlika rocks. Rocks of Stikine Terrane directly to the west may have formed the footwall to this thrust system. Alternatively, however, the Sitlika/Stikine contact might be part of a younger dextral strike-slip system, and the western panel of Sitlika clastic rocks might have been localized by this faulting rather than by earlier thrust imbrication.

The thrust contact between the Trembleur ultramafic unit and underlying Sitlika assemblage was observed on the north margin of the Mitchell batholith (Figure 3, Section A; Schiarizza *et al.*, 1998), whereas the contact between the ultramafic unit and the overlying phyllite-chert unit was observed at two localities north of the area shown in Figure 2 (Schiarizza and Payie, 1997). Both exposures display kinematic evidence for east-directed thrusting. The relationships between the three main levels of the thrust system are also apparent from exposures near Takla Narrows, where folds along the southern margin of the Mitchell batholith and a repetition due to a young east-side-down normal fault demonstrate the stacking order and the sheet-like nature of the Trembleur ultramafic unit (Figure 3, Section B).

The North Arm succession, comprising the upper, crustal portion of the Cache Creek ophiolite sequence, is widespread south of the Purvis Lake fault, but does not occur to the north. This is consistent with the interpretation of Whittaker (1983), who suggested that the ultramafic rocks in the Mitchell Range were derived from lower depleted mantle whereas those at Mount Sidney Williams represent upper depleted mantle. It suggests that the thrust faults bounding the ultramafic unit have ramped upward from north to south across the area presently occupied by the Purvis Lake fault. The North Arm succession occurs mainly above the ultramafic unit, across a contact that is at least in part faulted but is interpreted as representing the transition from mantle to crustal levels within the ophiolite sequence (Figure 3, Section D). Between Mount Sidney Williams and Tsitsutl Mountain, however, the North Arm succession also occurs structurally beneath the ultramafic unit, where it is inferred to comprise an imbricate fault slice along the footwall of the ophiolitic allochthon. A wide panel of the North Arm succession also occurs to the west of the Sitlika assemblage in the area between the Tildesley Creek and Trembleur Lake faults. It comprises a separate fault panel that must have been downdropped relative to the adjacent Sitlika rocks, either by normal faulting or an out-of-sequence east-dipping reverse fault. Displacement along this fault may not have been large if the Mount Sidney Williams area is broadly antiformal in nature, as suggested by the apparent envelopment of the ultramafic unit by the North Arm succession along the south shore of Trembleur Lake (Figure 2; Figure 3, Section C).

The east-dipping thrust fault that juxtaposes the Trembleur ultramafic unit above the Sitlika assemblage south of Tsayta Lake is truncated by the Early Cretaceous Mitchell batholith (Figure 2). Tighter constraints are placed on the age of imbricate thrusting within the Cache Creek Complex near Shass Mountain, where structures are cut by the 165 Ma McKnab Lake and older(?) Boer suite plutons (Struik, 1998; Struik and Orchard, 1998). The western end of the McKnab Lake pluton also cuts the fault contact between the Sitlika assemblage and Trembleur ultramafic unit near Cunningham Lake. These relationships indicate that imbrication of the Cache Creek Complex and Sitlika assemblage occurred in Early to Middle Jurassic time.

Stikine Belt

Volcanic flows and breccias of the Takla and Hazelton groups do not generally display the penetrative tectonic foliation that is typical of adjacent Sitlika and Cache Creek rocks, although sedimentary rocks within the Takla Group commonly show a moderately to strongly developed slaty cleavage, and clasts within conglomeratic intervals may be flattened in the plane of this cleavage. In contrast, both metavolcanic and metasedimentary rocks of the Asitka Group tend to be foliated, although it is not clear whether this is related to a pre-Takla deformational event or simply to relative depth in the stratigraphic sequence.

The thrust faults that form the major structural boundaries between the main lithotectonic units of Cache Creek Terrane are likewise not well represented in the Stikine Terrane, although an east-dippping thrust(?) fault that places the Takla Group above the Hazelton Group south-southeast of Takla Landing is of appropriate orientation and age (post Hazelton Group and pre 170 Ma Spike Peak pluton) to be correlative (Figure 2). Elsewhere, however, changes in stratigraphic level typically occur across apparently steeply-dipping northwest or northeast striking faults, giving rise to a pattern that suggests block faulting rather than thrusting.

The contact between rocks of Stikine Terrane and the adjacent Sitlika assemblage was not observed, but is fairly well constrained north of the Purvis Lake fault, as well as in the southern part of the map area, between Babine and Specularite lakes. In the northern part of the area the contact is apparently a steep fault that juxtaposes a narrow panel of Sitlika clastic rocks against various units of Stikine Terrane that are progressively truncated along the fault (Figure 2). Some of these truncated units, such as the thin sedimentary interval between the Takla and Hazelton groups, and the Takla Landing pluton, occur as narrow slivers along the fault zone north of the present map area (Schiarizza and Payie, 1997), suggesting that there has been significant dextral strike-slip along the fault. A southeast plunging asymmetric fold outlined by the Takla/Hazelton contact about 15 km north of Takla Narrows may have formed during dextral translation along the fault.

North of Babine Lake, the eastern boundary of Stikine Terrane appears to be a steep fault that juxtaposes the Taltapin metamorphic belt against the Sitlika volcanic unit. In contrast to other parts of the area, volcanic rocks of the Takla Group are commonly strongly foliated within and adjacent to this belt, as are the underlying Taltapin/Asitka rocks and the associated Butterfield Lake pluton. It is not clear, however, if movement along the bounding fault was linked to the deformation and metamorphism within the Taltapin belt, or if the bounding fault is only linked to the exhumation of these more deformed and higher grade rocks.

MINERAL OCCURRENCES

Mineral occurrences in the northern part of the Babine Lake - Takla Lake area (93N map sheet) were described by Schiarizza *et al.,* (1998). Here we discuss only those occurrences in the northwest quadrant of the Fort Fraser (93K) map sheet (Table 1; Figure 5).

Occurrences Within Stikine Terrane

BABS (MINFILE 93L 325)

The BABS property straddles the boundary between the 93K/13 and 93L/16 map sheets. This property was described in MacIntyre *et al.* (1996). Showings on the property include altered rhyolitic tuffs with low grade, disseminated chalcopyrite and a boulder train of well-mineralized biotite-feldspar porphyry typical of the Babine porphyry camp. The source of these boulders has not yet been located.

BL (MINFILE 93K 054)

The BL showing occurs in a region underlain dominantly by metasedimentary and metavolcanic rocks of the Takla Group and by pyroxenite, hornblende gabbro, diorite and chlorite schist of the Butterfield Lake pluton (Figure 5). Mineralization comprises disseminated chalcopyrite in pyroxenite and coarse-grained gabbro. Chalcopyrite and malachite also occur in andesite adjacent to a pyritic tuff unit. In 1987, a grab sample from an outcrop of pyroxenite containing chalcopyrite and malachite on the Butter claim assayed 0.053 percent copper (Shaede, 1998).

Mary Ann (MINFILE 93K 075)

The Mary Ann showing is located at the end of Wright Bay on Babine Lake (Figure 5). The showing comprises chalcopyrite and malachite in strongly deformed limestone interbedded with mafic volcanic rocks of the Pennsylvanian-Permian Asitka Group. The showing is near a northeast trending fault that juxtaposes Lower Jurassic Wright Bay succession of the Hazelton Group against metavolcanic and metasedimentary rocks of the Asitka Group. The showing may be related to hydrothermal activity along this fault.

Fort (MINFILE 93K 093)

Richard Haslinger staked the Fort property in late 1997 after Elden Nyberg discovered significant sulphide mineralization in rocks exposed along a new logging road in the 93K/12 map sheet. The property was subsequently optioned by Eastfield Resources who staked some 632 claim units in the vicinity of the new showing. The main target on the property is a breccia zone that is healed with calcite, quartz and locally high grade sulphide mineralization. The breccia is exposed sporadically over an area 700 metres long and up to 400 metres wide. Eight grab samples averaged 0.34 percent copper, 0.017 percent molybdenum and 72.3 grams per tonne silver. Three of the samples returned values ranging from 0.36 to 1.01 percent zinc and 0.33 to 0.48 percent lead. Gold values are generally low with the highest being 98 parts per billion (Eastfield Resources web site). Encouraged by these initial results, Eastfield entered into a joint venture agreement with Ascot Resources Ltd. to explore the property. In the summer of 1998, the joint venture did line-cutting, soil geochemistry, prospecting and an induced polarization survey. This work defined a 300 by 800 metre copper soil anomaly and coincident 1600 metre long IP chargeability high along the western margin of the Butterfield Lake pyroxenite intrusive complex (Ascot Resources web site). Although this work defined a number of potential exploration targets, Ascot Resources Ltd. decided to terminate its option agreement with Eastfield in the fall of 1998.

The Fort breccia zone is located approximately 700 metres due east of Specularite Lake (Figure 5) where it is exposed along a new logging road. This road is located at the base of a northwest trending ridge that is cored by the Butterfield Lake pyroxenite-hornblende gabbro intrusive complex. Contacts observed in road cuts suggest this complex dips moderately to the northeast and that its upper contact is intrusive into chlorite schists and metasedimentary rocks that are probably correlative with the Pennsylvanian-Permian Asitka Group. The pyroxenite is cut by potassic altered porphyritic monzonite to granodiorite dikes The southwest contact of the intrusive complex is interpreted to be a fault with weak to moderately deformed pyroxene phyric flows and breccias of the Upper Triassic Takla Group forming the struc-

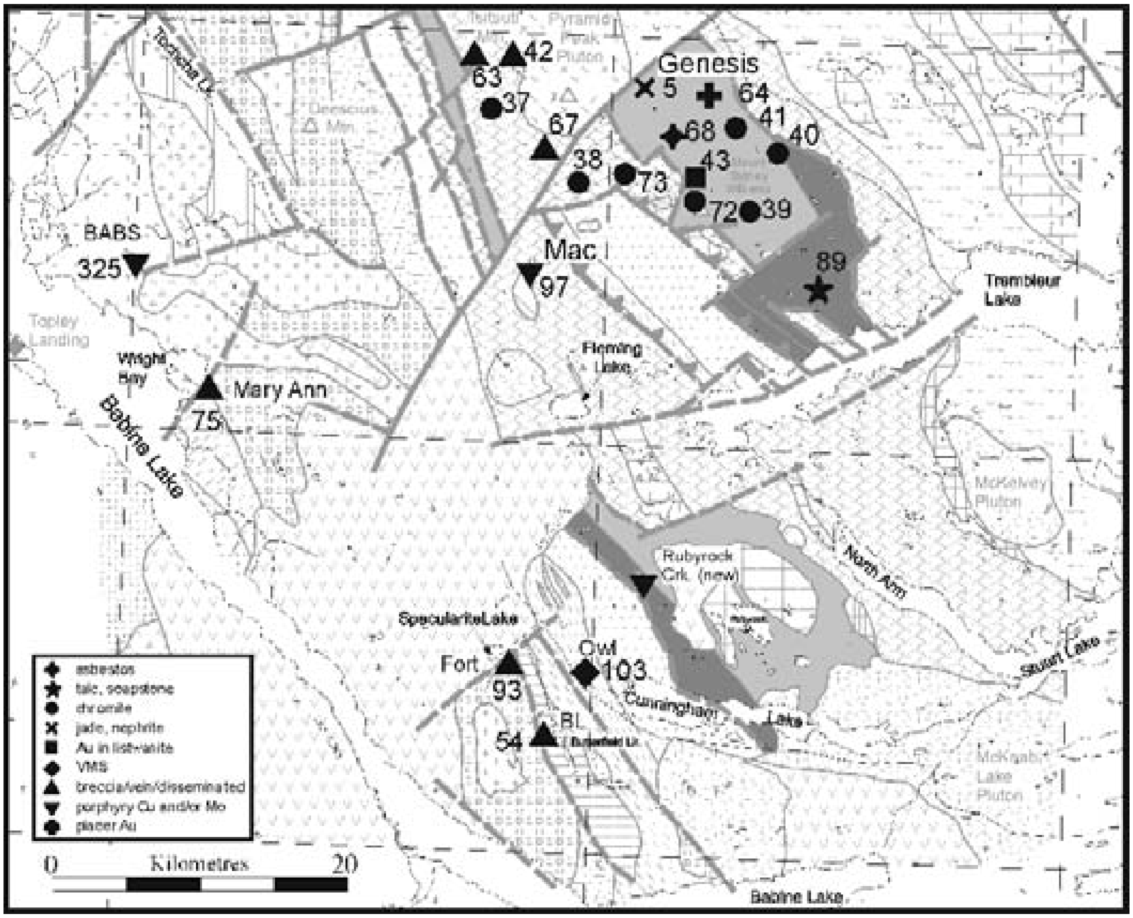

Figure 5. Generalized geology and location of mineral occurrences, northwest Fort Fraser (93K) map sheet. See Table 1 for list of occurrences and Figure 2b for legend.

tural footwall. The Fort breccia occurs at or near this structural contact and is interpreted to be a dilational zone related to faulting. The breccia is well exposed in a road cut where it is at least 200 metres wide. Several small outcrops of breccia occur up slope from the road cut and indicate that the breccia extends at least 400 metres to the southeast.

The Fort breccia is comprised of angular to subrounded, 2 to 20 centimetre clasts of pyroxenite, chlorite schist and fine grained foliated diorite to monzonite healed by coarse grained rhombs of calcite and well formed quartz crystals that have grown in open cavities. In places the breccia matrix, which locally has remnant vuggy cavities, also contains abundant chlorite and biotite. The breccia varies from clast to matrix supported. Sulphide mineralization is interstitial to breccia clasts although clasts may also have some disseminated pyrite and chalcopyrite. Interstitial sulphides are intergrown with calcite and quartz and are typically coarse grained and in places massive. Pyrite is the most abundant sulphide mineral but chalcopyrite is locally abundant as high grade intergrowths with pyrite. Other, less common suphide minerals include molybdenite, sphalerite and galena. Alteration associated with the breccia is mainly potassium feldspar, green biotite and silica.

Minerals in-filling the Fort breccia are coarsely crystalline and have clearly formed slowly from relatively low temperature fluids circulating through open spaces in the breccia. The matrix minerals are undeformed and this suggests healing of the breccia post dates tectonic activity. The predominance of metamorphic and foliated intrusive clasts in the breccia suggests the Butterfield Lake intrusive was the primary protolith to the breccia. The breccia does not appear to cut younger diorite, quartz latite and hornblende-biotite-feldspar porphyry dikes that intrude the complex to the east and up slope from the breccia. However, hydrothermal activity may have been related to heat flow generated by emplacement of these dikes. Similar dikes occur on ridges in the northern part of the property and have produced zones of disseminated pyrite along their margins. Biotite from one of these dikes

Table 1. Mineral occurrences in the northwest Fort Fraser map sheet

Minfile No.	Names	Status	Commodity	Map Sheet	Type
093K 005	GENESIS, GREEN, JADE QUEEN, O'NE-ELL CREEK, TEZZERON NEPHRITE	Past Producer	Nephrite, tremolite	093K14W	Jade
093K 037	TSITSUTL MOUNTAIN CHROMIUM	Showing	Cr	093K13E	Podiform chromite
093K 038	TILDESLEY CREEK	Showing	Cr	093K13E	Podiform chromite.
093K 039	MT. SIDNEY WILLIAMS, CR, VAN 1, P.G.4, PG-3,	Showing	Cr	093K14W	Podiform chromite
093K 040	PAULINE, MIDDLE RIVER RIDGE, PG, P.G.	Showing	Cr	093K14W	Podiform chromite
093K 041	VAN DECAR CREEK, PG,	Showing	Cr	093K14W	Podiform chromite
093K 042	TSITSUTL MOUNTAIN TIN	Showing	Sn, Mn, V, Co, Zn, Rhodonite	093K13E	Veins
093K 043	MT. SIDNEY WILLIAMS, VAN, KLONE	Showing	Au, Ag, Cr, Asbestos	093K14W	listwanite-hosted Au
093K 054	BL, SMJ, BUTTER	Showing	Cu	093K12E	Vein, disseminated
093K 063	TSITSUTL MOUNTAIN	Showing	Cu	093K13E	Disseminated
093K 064	VAN DECAR CREEK PLACER	Showing	Au	093K14W	Surficial placer
093K 067	DIANE, BORNITE	Showing	Cu, Au, Zn	093K13E	Vein, disseminated
093K 068	VAN DECAR ASBESTOS	Showing	Asbestos	093K14W	Ultramafic-hosted asbestos
093K 072	SIDNEY	Showing	Cr	093K14W	Podiform chromite
093K 073	O'NE-ELL CREEK	Showing	Cr	093K14W	Podiform chromite
093K 075	MARY ANN, DAVE	Showing	Cu	093K13W	Vein, disseminated
093K 089	BAPTISTE, MOUNT SIDNEY WILLIAMS	Showing	Talc, Soapstone	093K14W	Ultramafic-hosted talc-magnesite
093K 093	FORT, SPECULARITE LAKE, ELDEN	Showing	Cu, Ag, Mo, Pb, Zn	093K12E	Breccia, vein
093K 097	MAC, CAMP, PAULA CREEK, PEAK, POND	Developed Prospect	Mo, Cu	093K13E	Porphyry Mo (Low F-type)
093K 103	OWL, FORT, BUT 4	Showing	Cu, Ag, Au, Zn, Pb	093K12E 093K11W	Volcanogenic massive sulphide; quartz veins
093L 325	BABS	Prospect	Cu, Au	093L16E, 093K13W	Porphyry Cu ± Mo ± Au
	RUBYROCK CREEK	Showing	Cu	093K11W	Porphyry Cu

gave a 52 Ma Ar-Ar isotopic age and a similar age is implied for mineralization at the Fort. A sample of hydrothermal biotite has been submitted for Ar-Ar isotopic dating.

Pyroxenite, hornblende gabbro and diorite with narrow panels of chlorite schist are exposed in road cuts northeast of the breccia. These rocks, which are interpreted to be in the structural hangingwall of the breccia, contain disseminated pyrite and minor chalcopyrite and are cut by numerous small breccia lenses and quartz-carbonate veins with potassic alteration selvages. The veins and breccia lenses strike southeast, dip moderately to the northeast and appear to parallel the trend of the main breccia body. In contrast, Takla volcanic rocks, which presumably lie structurally below the breccia, lack significant sulphide mineralization or veining. This suggests that hydrothermal fluids circulating through the breccia moved upward into a shattered hanging-wall but did not penetrate downward into a more massive and impermeable footwall.

The northwest extension of the Fort breccia is probably truncated by a northeast trending high angle fault that is coincident with a topographic linear. Eocene volcanic rocks crop out in the low-lying region west of the fault and are interpreted to be in a downdropped block. The same fault terminates the aeromagnetic anomaly associated with the Butterfield lake pyroxenite body northeast of the breccia zone. This fault may also have been a conduit for hydrothermal activity in Eocene or younger time and could potentially be a drill target.

If the breccia at the Fort property is tectonic in origin and related to development of a dilational zone along the western margin of the Butterfield Lake pyroxenite intrusive complex then this contact may have potential for additional discoveries elsewhere along its length.

Occurrences Within the Sitlika Assemblage

Owl (MINFILE 93K 103)

The Owl claims were staked in 1989 and 1990 to cover mineralized outcrops exposed along and adjacent to the Cunningham Lake Forest Service road, about 2 km west of the west end of Cunningham Lake. The claims were explored in 1990 through 1992, but were subsequently allowed to lapse. The showing is presently included in ground staked after discovery of the Fort occurrence, 5 km to the west-northwest.

Mineralization at the Owl showing is within a succession of predominantly rhyolitic to dacitic metavolcanic rocks that are here assigned to the Sitlika volcanic unit. It is developed sporadically over a strike length of 2 km, and includes disseminated chalcopyrite-pyrite within the metavolcanics, as well as quartz and quartz-carbonate veins and stringers that locally contain significant amounts of copper, gold and silver (Halleran and Halleran, 1990; Halleran, 1991). In addition, several massive sulphide boulders were discovered in the vicinity of the mineralized outcrops. These, combined with the predominance of felsic metavolcanic rocks in this part of the Kutcho-correlative Sitlika volcanic unit, suggest that this area may warrant further exploration for volcanogenic massive sulphide mineralization.

Occurrences Within the Cache Creek Belt

Chromite

MINFILE lists six chromite occurrences within the Cache Creek ultramafic unit in the Mount Sidney Williams area (93K 038, 039, 040, 041, 072, 073), and another within the same unit south of Tsitsutl Mountain (93K 037) (Figure 5). All of these showings were mapped by Armstrong (1949), who provided brief descriptions of the 5 most important occurrences. Subsequent work included prospecting and rock sampling programs over the Pauline showing in 1974 (MINFILE 93K 040; Stelling, 1975), and the Van Decar Creek showing in 1979 (MINFILE 93K 041; Guinet, 1980). In 1982 Northgane Minerals Ltd. commissioned an airborne VLF-EM and Magnetometer survey over the 4 occurrences east and northeast of Mount Sidney Williams (Pezzot and Vincent, 1982), but no follow-up work was recorded. The Mount Sidney Williams area was also examined by Whittaker (1983) as part of a broader study of chromite occurrences associated with alpine-type peridotites in southern and central British Columbia.

The chromite occurrences in the Mount Sidney Williams - Tsitsutl Mountain area, none of which were examined during the present study, comprise massive pods and disseminations within dunite. Armstrong (1949) reported that the best occurrence, Van Decar Creek, includes a lens measuring about 1.5 m by 8 m in surface area containing at least 50% chromite, as well as an adjacent zone of disseminated chromite. This lens was hand trenched and sampled by Guinet (1980), who reports Cr values ranging from 17.7 percent to 38.9 percent.

Mt. Sidney Williams Au (MINFILE 93K 043)

The Mt. Sidney Williams area, underlain by the Trembleur ultramafic unit and associated North Arm succession, was investigated as a possible platinum/gold prospect in 1987 (Mowat, 1988a). Geochemical sampling at this time yielded only a single sample with a slightly elevated Pt/Pd value, but significant gold values were obtained from silt and listwanite-altered rock samples. Subsequent exploration from 1988 through 1994 focused on these and other auriferous listwanite zones, although mention was also made of chromium and asbestos occurrences. Early work during this exploration phase consisted mainly of prospecting and mapping together with soil, silt and rock geochemical surveys (Mowat, 1988b). Subsequent work included trenching, geophysical surveys and diamond drilling (Mowat, 1990, 1991, 1994). More recent work, while continuing to address gold mineralization, has also been concerned with the nickelcobalt potential of the area (Mowat, 1997).

The Mt. Sidney Williams gold prospect was not examined during the present study. Elevated gold values occur mainly in listwanite alteration zones and are specifically associated with arsenopyrite that is erratically distributed along fault zones and in areas of intense silicification (Mowat, 1990). Mowat (1990, 1994) reports that the auriferous listwanites show a spatial relationship to norite intrusions. C. Ash collected a sample from one of the Mt. Sidney Williams listwanites in 1992, and submitted it to P.H. Reynolds of Dalhousie University for Ar-Ar dating of mariposite. The age spectrum (provided to the authors by C. Ash) shows prominent plateaus at about 170 and 180 Ma, but these dates must be considered preliminary as we do not, at this time, have a report on the quality or error limits associated with the data. Nevertheless, the suggested Middle Jurassic age for the listwanite alteration and associated gold mineralization is intriguing, as it coincides with the inferred age of thrust-imbrication of the Cache Creek assemblage. This, together with the setting of the occurrence near the structural base of the Mt. Sidney Williams ultramafic allochthon (Figure 3, Section C) suggests that the alteration and mineralization may, at least in part, be controlled by structures associated with this thrust-imbrication.

Diane (MINFILE 93K 067)

The Diane claim group was staked on the west side of upper Tildesley Creek in 1969, to cover an area of anomalous copper values identified in a reconnaissance silt sampling program. Soil sampling, electromagnetic and magnetic surveys were conducted over the claims later that year (Dodson, 1970), but no follow-up work was recorded and the Diane claims were allowed to lapse. The area was subsequently re-staked as the western part of the Bornite claim group, which was subjected to a soil sampling, chip sampling and diamond drilling program in 1995 (Mowat, 1996).

The area of the original Diane claims, on the west side of Tildesley Creek, is underlain by the North Arm succession of the Cache Creek Complex, comprising variably foliated mafic metavolcanic and meta-intrusive rocks along with local metasedimentary intervals. Three holes from 2 setups were drilled into this succession in 1995 to test copper-in-soils anomalies. The holes all encountered sub-economic chalcopyrite mineralization within a succession of predominantly chlorite-epidote-actinolite-calcite-altered mafic volcanic rocks. Slightly anomalous gold concentrations were associated with the highest copper concentrations (up to 500 ppm Cu) in all three holes (Mowat, 1996).

The eastern part of the Diane claim group, on the east side of Tildesley Creek, is underlain by fault-imbricated slivers of ultramafic rock, slate and siltstone, and greenstone. These rocks are inferred to represent either the North Arm succession or the Sitlika assemblage imbricated with the ultramafic unit in the footwall of the Mount Sidney Williams ultramafic allochthon (*e.g.* Figure 3, Section C). Mowat (1996) reports that the metasedimentary rocks, which are highly anomalous in Zn, Ag and Ba, host bedding-parallel sulphide mineralization consisting of pyrrhotite with minor chalcopyrite intergrowths.

Tsitsutl Mountain Tin (MINFILE 93K 042)

The Tsitsutl Mountain tin occurrence comprises a vein of rhodonite that contains minor amounts of tin, zinc, manganese, vanadium and cobalt. It occurs on the ridge south of Tsitsutl Mountain, within metasedimentary rocks of the North Arm succession near the contact of a small quartz porphyry stock. The vein was discovered in 1942 and explored in 1943 (Armstrong, 1949, page 194), but has not apparently received any recent attention. The northwest striking vein consists of about 70 percent rhodonite, with 2 to 3 percent arsenopyrite and variable amounts of calcite, garnet and ilmenite. It was uncovered at two places, a little more than 7 m apart, where it is 46 and 61 cm wide, respectively. Armstrong reports that an assay of vein material yielded 0.37 percent zinc and 0.09 percent tin, whereas specimens of wall-rock contained 0.65 percent vanadium oxide.

Mac (MINFILE 93K 097)

The Mac porphyry molybdenum prospect has been described in a previous report (MacIntyre *et al.*, 1998). No significant work was done on the property in 1998.

The Mac property is underlain by metavolcanic, metasedimentary and serpentinized ultramafic rocks that are here included in the North Arm succession of the Cache Creek Complex. These rocks are intruded by stocks of biotite granodiorite to porphyritic quartz monzonite that are part of the latest Jurassic to earliest Cretaceous Francois Lake intrusive suite. These intrusions also host the Endako porphyry molybdenum deposit in the Fraser Lake area, approximately 90 kilometres south-southeast of the Mac. As at Endako, molybdenum mineralization at Mac is associated with these intrusions and occurs in three areas - the Peak, Camp and Pond zones. Drilling to date has mainly focused on the Camp zone. There, a 300 by 500 metre, northerly elongate stock of porphyritic quartz monzonite intrudes the Cache Creek Complex. The southern end of the stock is truncated and possibly offset southeastward by a northwest trending, high angle, sinistral strike-slip fault. The intrusion is medium-grained, leucocratic, and porphyritic to equigranular with 15 percent 1-3 millimetre feldspar, 25 percent 1-2 millimetre quartz, 35-45 percent 1-4 millimetre K-feldspar, and up to 5 percent biotite, muscovite and hornblende (Cope and Spence, 1995).

Molybdenum mineralization at Mac occurs as molybdenite on fractures, as disseminations and in quartz veinlet stockworks peripheral to and within the porphyritic quartz monzonite or granite stock. Where the quartz monzonite stock is exposed on surface it is leached and has only minor ferrimolybdite staining on fractures. Disseminated chalcopyrite also occurs in the mineralized zones at Mac. Drill results indicate that the best molybdenum grades occur in a 50 metre wide zone of biotite-bearing, hornfelsed rocks along the east, north and west contacts of the stock. One of the best drill intersections from this zone was 90 metres grading 0.308 percent MoS_2 and 0.256 percent Cu. A pyritic halo also encloses the stock and is roughly coincident with the biotite hornfels zone. Limited drilling in the Peak and Pond zones has intersected similar styles of mineralization. These zones are still relatively untested.

Rubyrock Creek (new)

Mapping within the Trembleur ultramafic unit along the crest of the ridge northeast of Rubyrock Creek in the 93K/11 map sheet resulted in the discovery of several small outcrops of crowded biotite-feldspar porphyritic granodiorite with up to 15 percent disseminated and fracture controlled pyrite. These outcrops occur in a small saddle and define an area of sulphide mineralization that is at least 300 metres long and 200 metres wide. The extent of mineralization, which is centered at UTM coordinates 341970E, 6062210N (NAD83), is constrained to the west by the occurrence of unmineralized serpentinite but is open in all other directions. A single sample collected from this locality contained 183 ppm Cu. The discovery is considered significant because the style of sulphide mineralization and the nature of the porphyritic host rocks suggest the presence of a porphyry copper style hydrothermal system of probable Eocene age. Although no significant copper mineralization was located within the zone of disseminated and fracture controlled pyrite, followup work may locate a copper rich zone associated with the porphyritic intrusions.

Genesis Jade Deposit (MINFILE 93K 005)

The Genesis deposit is located on O'Ne-ell Creek, a little more than 5 km upstream from its confluence with the Middle River. It was discovered in 1968 by Ms. W. Robertson, who found jade boulders along the creek and traced them upstream to the in situ nephrite outcrop. Limited production, from boulders and bedrock, took place from 1968 through 1970 (B.C. Minister of Mines and Petroleum Resources Annual Report, 1968, p. 309; Geology, Exploration and Mining in British Columbia, 1969, p. 389; 1970, p. 498). The deposit was re-staked as the Green 1-4 claims in 1993, and Global Metals Ltd. tested the nephrite with 29 shallow diamond drill holes in 1995 (McIntyre and McIntyre, 1995). No subsequent development has been reported.

The Genesis deposit is within the Trembleur ultramafic unit, about 2 km southeast of the inferred trace of the Tildesley Creek fault. It comprises lenses of nephrite, massive tremolite, and foliated tremolite-talc-chlorite rock within a structurally complex contact zone between serpentinite and an overlying assemblage of metasedimentary and metavolcanic rocks that includes chert, quartzite, greenstone, slate and sandstone (Fraser, 1972; McIntyre and McIntyre, 1995). The metasedimentary and metavolcanic rocks are inferred to be a tectonic inclusion within the ultramafic unit, although it is possibly that they represent part of the structurally overlying North Arm succession. McIntyre and McIntyre (1995) estimate that about 2 800 000 kg of marketable stone are present on the property, including both nephrite and hard, polishable milky grey tremolite.

Talc and Soapstone

As described in a previous section, massive to weakly foliated carbonate-talc rocks dominate the Trembleur ultramafic unit over a broad area east and southeast of Mt. Sidney Williams. The Baptiste MINFILE occurrence (93K 089) is located in this area, apparently on the basis of Armstrong's (1949, page 89) report that "talc-carbonate rocks predominate in the southern half of the Mount Sydney Williams peridotitic batholith, underlying most of the area between Baptiste Creek and Trembleur Lake." Although there are no assessment reports related to talc exploration on file, sawn blocks noted at two localities during the course of this year's fieldwork attest to some recent interest in this commodity. Of particular interest is a lens of almost pure talc exposed over several square metres within more typical marble-textured carbonate-talc rock. This locality, 7.5 km east-southeast of Mount Sidney Williams, is covered by the Dial claim, owned by A.D. Halleran of Fort St. James.

Asbestos

Armstrong (1949, page 197) describes a deposit of chrysotile asbestos on the north slope of Mount Sidney Williams, and a separate occurrence of tremolite asbestos about 3 km to the northwest. The former is in the area of the Mount Sidney Williams Au prospect (MINFILE 93K 043), and the latter is referred to as the Van Decar asbestos occurrence (MINFILE 93K 068). Armstrong considered the asbestos in both areas to be of poor commercial quality, but noted that this did not preclude there being better quality material elsewhere within the Trembleur ultramafic unit. However, there is no record of subsequent exploration directed toward this commodity.

Placer Gold

Van Decar Creek, which flows northeastward from Mount Sidney Williams to the Middle River, yielded a minor amount of placer gold in the 1930s, from workings about 3 km above its mouth (Armstrong, 1949, page 152; MINFILE 93K 064). The Van Decar Creek drainage basin is entirely within the Trembleur ultramafic unit, and includes the gold-bearing listwanites of the Mount Sidney Williams prospect (MINFILE 93K 043).

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