GEOLOGY, MINERALIZATION AND LITHOGEOCHEMISTRY OF THE STUART LAKE AREA, CENTRAL BRITISH COLUMBIA (PARTS OF 93K/7, 8, 10 and 11)

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KEYWORDS: Regional geology, Cache Creek Terrane, Stuart Lake belt, ophiolitic remnant, subduction complex, mesothermal veins, gold.

INTRODUCTION

Economic mineral deposits found in oceanic terranes include: mesothermal gold-quartz veins, Cyprus-type massive sulphide, podiform chromite, platinum or cobalt associated with nickel sulphides, as well as asbestos and jade deposits. These are either hosted by, or otherwise closely associated with oceanic crustal or mantle lithologies. Mesothermal gold-quartz veins and related placers are historically the most economically significant in British Columbia. Ophiolitic crustal and upper mantle rocks are significant in that they delineate deep crustal faults, a first order control for the development of mesothermal veins. Recognition of these lithologies is therefore an important criterion in identifying areas of high mineral potential. Due to their tectonic formation these oceanic terranes are lithologically heterogeneous in detail and they remain undifferentiated on many current geological maps as a result of the small scale of previous mapping. This is particularly true for rocks of the Cache Creek Terrane (CC) in central British Columbia (Stuart Lake belt) where the existing geological database was compiled at 1:380 160 scale (1 inch to 6 miles) almost half a century ago (Armstrong, 1949; Rice, 1949).

During the 1992 field season three weeks were spent geological mapping at 1:50 000 scale in the Stuart Lake area, northeast of Fort St. James in central British Columbia (Figure 1-6-1). The area mapped occupies a northwest-trending belt to the southwest and northeast of Stuart Lake and includes parts of the NTS 93K/7 (Shass Mountain), 93K/8 (Fort St. James), 93K/10 (Stuart Lake) and 93K/11 (Cunningham Lake) map sheets. It was selected for mapping in order to provide a revised and more detailed geological database needed to evaluate its mineral potential. Stuart Lake itself, and an extensive network of logging roads with a high percentage of forest clear-cut to the west of the lake, provided easy access to a large area. Mapping has been compiled at 1:100 000-scale and combined with the geology of Paterson (1973) for the Pinchi Lake area east of Stuart Lake (Ash *et al.*, 1993).

Previous investigations by the authors in this area focused on characterizing the tectonic setting and timing of gold-quartz vein mineralization and associated felsic intrusive rocks at the Snowbird antimony-gold mesothermal vein deposit (Ash *et al.*, in preparation).

This report describes the geology and discusses the mineral potential of the area mapped. Whole-rock major, trace and rare-earth elemental data obtained for metabasalts from the Pinchi and southern Stuart Lake area are presented and used to interpret the paleotectonic setting of these oceanic rocks.

PREVIOUS WORK

Earliest published geological maps of the region are those of Armstrong (1942a, 1944), which focused on a north-trending belt 20 kilometres wide, centred on the Pinchi fault zone. Armstrong (1949) also conducted the first systematic mapping of the region. He subdivided the Cache Creek rocks into two units, including both limestones and a mixed sedimentary suite of argillites and cherts with subordinate mafic volcanics. Ultramafic rocks throughout the belt were referred to as the "Trembleur intrusions", which he interpreted to be later, crosscutting plutons. Subsequently, Rice (1949) produced a 1:506 880-scale geological compilation and mineral occurrence map for the Smithers - Fort St. James area.

Paterson (1973; 1977) mapped and described the geology of the Pinchi Lake area and determined that the lithologies present were consistent with those of a dismembered

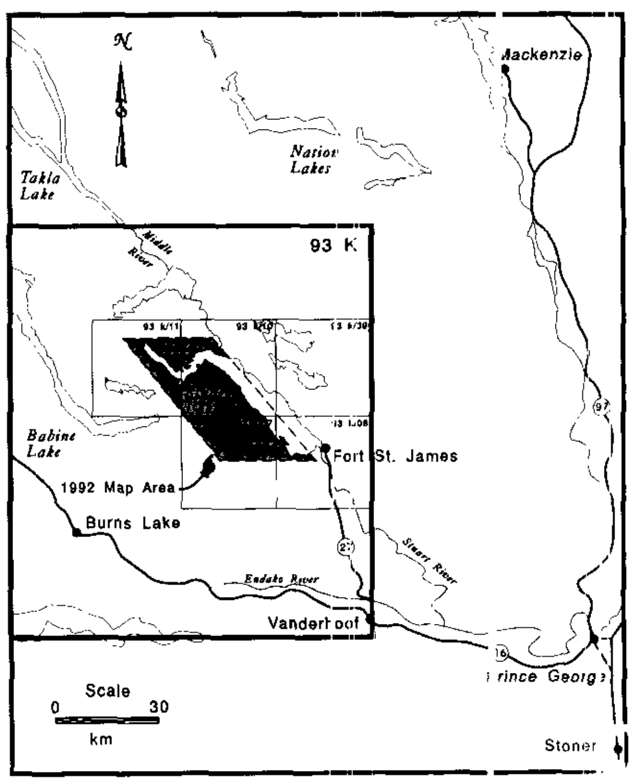

Figure 1-6-1. Location of the Stuart Lake map area.

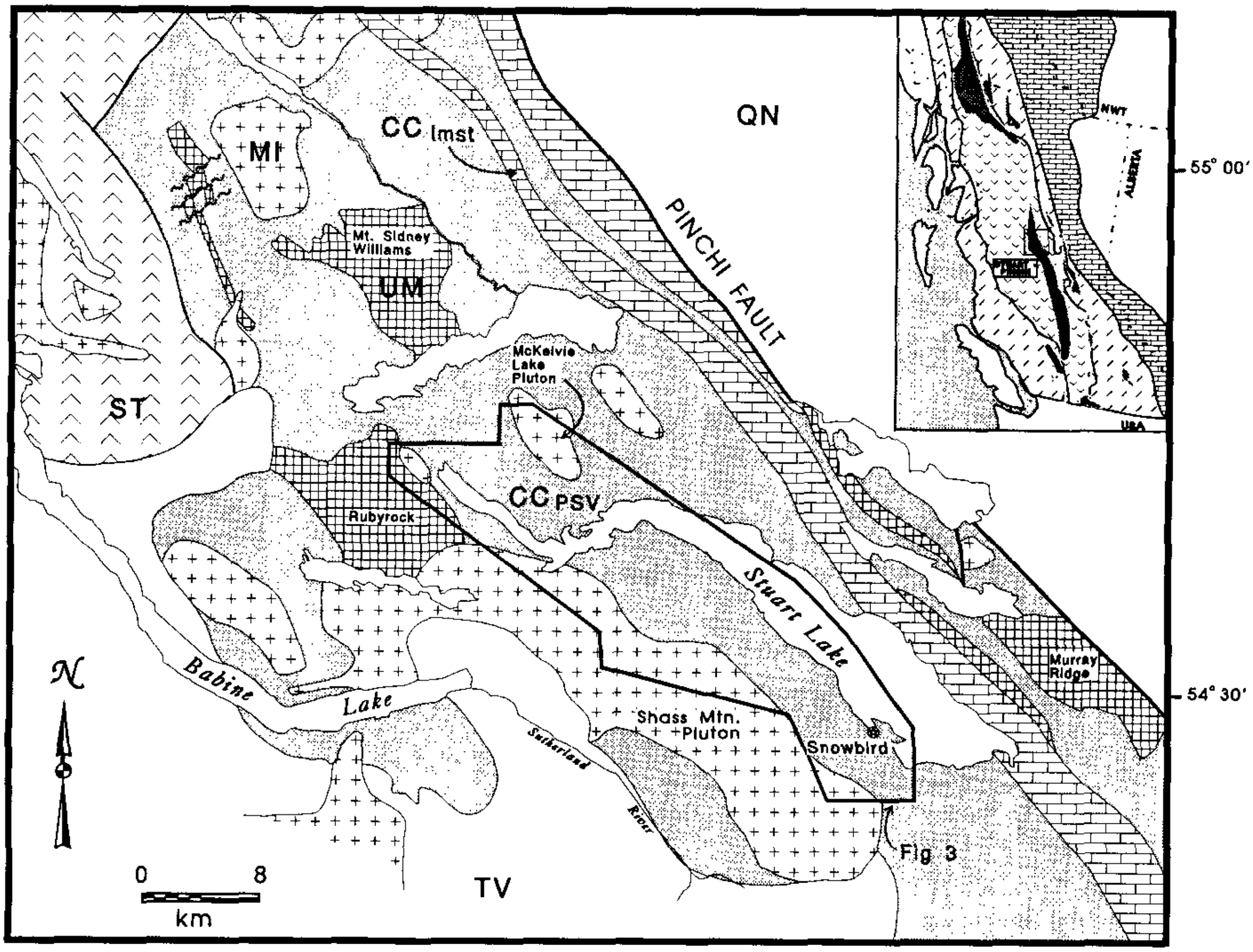

Figure 1-6-2. Regional geology of the southern Stuart Lake belt. CC = Cache Creek, PSV = Pelagic sediments and volcanics, lmst = Limestone, QN = Quesnellia, ST = Stkinia, TV = Tertiary Volcanics, MI = Mesozoic intrusions, UM = ultramafic rocks.

ophiolite suite. He suggested that the Pinchi fault may represent a fossil oceanic transform fault.

Ross (1977) documented the detailed structural history of ultramafic rocks underlying Murray Ridge to the southeast of Pinchi Lake. He defined three generations of fabric in the residual harzburgite and concluded that the two earlier fabrics were generated by mantle transport and the later fabric by high-level structural emplacement (obduction). Whittaker (1982a, b; 1983a, b) and Whittaker and Watkinson (1981; 1983; 1984; 1986) presented detailed petrological and phase chemistry data for the majority of the larger ultramafic bodies in the region which support the interpretation that they are obducted fragments of uppermost oceanic mantle material.

The geology of the Snowbird deposit (Game and Sampson, 1987a, b) and the area immediately to the west (Callan, personal communication, 1991) have been mapped in detail.

REGIONAL GEOLOGICAL SETTING

The study area covers late Paleozoic to early Mesozoic oceanic rocks of the Cache Creek Terrane (Figure 1-6-2). The Cache Creek Terrane in central British Columbia forms a north-trending belt, 450 kilometres long, which averages 60 kilometres in width, and is referred to as the Stuart Lake belt (Armstrong, 1949). Bounded by faults, this belt comprises a tectonically intercalated package of undifferentiated pelagic sediments, limestones and subordinate oceanic metavolcanic and plutonic ultramafic rocks.

The age of the Cache Creek rocks in this region is solely constrained by paleontological data. Limestones throughout the belt contain fusulinids that range in age from Pennsylvanian to Late Permian (Armstrong, 1949; Thompson, 1965). Conodonts from massive carbonate near Fort St. James indicate a middle Pennsylvanian (Moscovian) age (Orchard, 1991). Cherts collected from the shore of Stuart Lake within the town of Fort St. James contain upper Norian conodonts

(Orchard, 1991) and Carnian radiolaria (Cordey, 1990a, b). Available fossil evidence thus places the currently defined upper age of the Stuart Lake Belt at middle Upper Triassic (Norian). This interpretation is, however, based on a very limited number of samples. By comparison, the youngest fossils identified from silicious pelagic sedimentary rocks in the Atlin Terrane are Early Jurassic in age (Cordey *et al.*, 1991) and the Stuart Lake belt probably has a similar age range.

Several large ultramafic bodies, including Murray Ridge, Mount Sydney Williams and Ruby Rock are exposed within the belt (Figure 1-6-2). These consist of harzburgite with subordinate dunite and pyroxenite or their serpentinized equivalents and are interpreted to represent residual upper-mantle material tectonically emplaced into their present positions (Paterson, 1973, 1977; Ross, 1977; Whittaker, 1982a, b, 1983a, b; Whittaker and Watkinson, 1981, 1983, 1984, 1986). Most commonly exposed as topographic highs, the inferred contacts of these ultramafic bodies tend to be circular, maintaining a consistent topographic elevation, suggesting that they may represent relatively flat-lying thrust sheets that form isolated klippen.

Cache Creek oceanic rocks are intruded throughout by Middle Jurassic and later felsic plutonic rocks that include diorites, granodiorites, tonalites and granites (Armstrong, 1949; Carter, 1981; Ash *et al.*, in preparation). These intrusions were initially divided into both the Topley and Omineca suites by Armstrong. Carter later subdivided the Topley intrusions of Armstrong into the Francois Lake and Topley suites which he defined on the basis of K-Ar mica age groupings at 173 to 206 Ma and 133 to 155 Ma, respectively.

Along its eastern margin the belt is separated from the early Mesozoic Takla rocks of the volcanic-plutonic arc terrane of Quesnellia by the Pinchi fault zone (Armstrong, 1949). Paterson (1977) described the fault zone in the Pinchi Lake area as a series of elongate fault-bounded blocks of contrasting lithology and metamorphic grade. It is interpreted as a high-angle transcurrent structure (Gabrielse, 1985) with the earliest movement occurring before the Late Cretaceous and recording a protracted history of displacement from Middle Cretaceous to Oligocene time. In the Pinchi lake area, Patterson (1973, 1977) described a belt of glaucophane-lawsonite-bearing mafic metavolcanics and metasediments within and paralleling the Pinchi fault zone that indicate a blueschist grade of metamorphism. Four K-Ar dates on muscovite from these blueschists range from 212 to 218$\pm$7 Ma, indicating a Late Triassic metamorphic age (Paterson and Harakal, 1974). Referred to by Armstrong (1966) as the Pinchi mercury belt, the Pinchi fault is a strongly carbonatized zone with associated mercury mineralization occurring intermittently along most of its exposed length (Armstrong, 1942a, b, 1949, 1966; Rice, 1949). The Pinchi mine is the only significant mercury producer; during two periods of operation (1940-44, 1968-75) it produced 6.28 million kilograms (182 296 flasks) of mercury from 2.23 million tons of ore milled (I. A. Paterson, personal communication, 1992).

Contact relationships along the western margin of the central and southern parts of the belt are poorly defined, as they are masked by both Tertiary volcanic rocks and heavy drift cover. To the north, the western boundary of the belt is marked by the Vital fault, an easterly dipping thrust fault which places Cache Creek rocks over the Sitlika assemblage (Paterson, 1974, Monger *et al.*, 1978) an enigmatic sequence of Upper Triassic to possibly Lower Jurassic volcano-sedimentary rocks (Paterson, 1974) which shows similar lithologic and tectonostratigraphic relationships to the Kutcho Formation along the southeast boundary of the Atlin Terrane (Thorstad and Gabrielse, 1986). These rocks are tentatively included with the Cache Creek Terrane (Gabrielse, 1991) and considered to be related to the destructive stage of the Cache Creek ocean basin. The unit is separated from arc-volcanic and plutonic rocks of Stikinia by the Takla fault to the west.

GEOLOGY OF THE STUART LAKE MAP AREA

The study area is underlain by accreted oceanic sedimentary, crustal and upper mantle lithologies which are cut by Middle Jurasic and and possibly younger felsic plutonic rocks (Figure 1-6-3). Pelagic sediments with lesser limestone are the dominant rock types. Oceanic crustal lithologies, including mafic volcanic as well as mafic and ultramafic plutonic rocks, are found closely associated in several localities throughout the map area. Due to lack of exposure, contact relationships are poorly defined, however, most are interpreted to be tectonic.

SEDIMENTARY ROCKS

Pelagic sedimentary rocks including argillite and mixed argillite and siliceous siltstone with lesser ribboned chert dominate the map sheet. Limestone occurs in rare bedded sections but is most common as massive blocks within tectonized argillite. A geographically and lithologically distinctive bedded sandstone-argillite unit is also present.

ARGILLITE AND PHYLLITIC ARGILLITE

"Argillite" enclosing pods and slivers of limestone, ribboned chert and metavolcanic rocks is regionally the most widely exposed rock type and dominates the central, lower lying areas of the map sheet. This unit, although dominated by siltstone, contains variable amounts of finer grained mudstone and therefore the more general term argillite is used. In most outcrops it is homogeneous, variably cleaved to fissile and rarely retains any primary bedding (Plate 1-6-1). The rocks are dark grey to black and weather dark to light grey and occasionally rust-brown as a function of localized iron staining. More massive, lighter weathering lenses of chert or siliceous argillite (Plate 1-6-2) are common throughout the unit. Siliceous lenses are characterized by moderate to high aspect ratios and are usually from one to several centimetres wide and from ten to several tens of centimetres long, with long axes parallel to the dominant foliation fabric in the surrounding clastic rocks. The abundance of these lenses is both highly variable and erratic, ranging from a few identifiable lenses in more homogeneous exposures to locally comprising from 40 to 60 per cent of the outcrop. Exposures with abundant siliceous

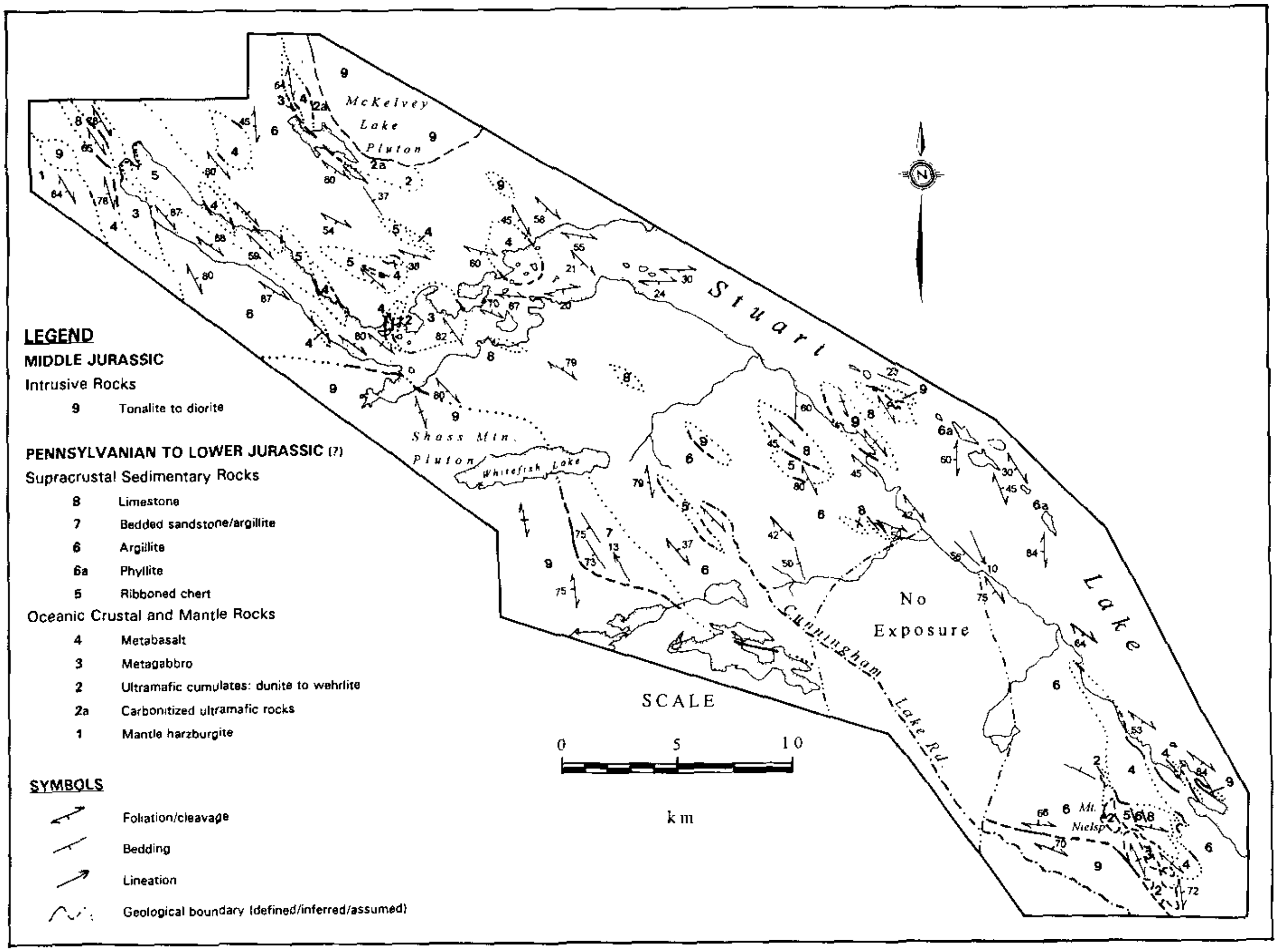

Figure 1-6-3. Generalized geology of the Stuart Lake map area.

Plate 1-6-1. Weathering appearance of strongly sheared, relatively homogeneous argillite.

Plate 1-6-2. Inhomogeneously sheared chert/siltstone and siliceous siltstone. Competent clasts are flattened, augened at their margins and are parallel to the dominant foliation fabric.

lenses were mapped as a distinct, mixed chert-argillite unit. The mixed unit rarely has any definable continuity at the present scale of mapping and is not distinguished on Figure 1-6-3.

Phyllitic varieties of the unit predominate along the shorelines of a northwest-trending chain of islands in Stuart Lake, in the east-central part of the map area. This subunit is clearly much more micaceous and weathered exposures have a silvery grey sheen reflecting their higher metamorphic grade. Siliceous or cherty lenses also characterize the phyllite but are much more attenuated and contorted than their counterparts in lower grade rocks. As the volume of siliceous lenses increases, an anastmosing fabric develops in the finer grained sediments accentuating the competency contrast between the two rock types (Plate 1-6-3).

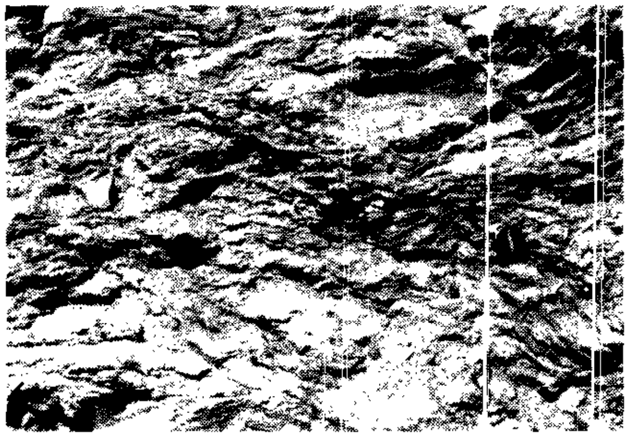

Plate 1-6-3. Competent lenses of siliceous argillite are parallel to the dominant foliation of the sheared argillaceous matrix.

RIBBONED CHERT

Ribboned chert is best exposed along the northeast side of the North Arm of Stuart Lake where it forms a belt of intermittent outcrops along the shoreline. It also occurs as isolated exposures throughout the argillite unit. Ribboned chert is commonly associated with the metavolcanic rocks, possibly reflecting a paleotectonic pre-emplacement stratigraphic relationship. It is very distinctive in outcrop, consisting of rhythmically layered massive chert beds with thinner interbeds of fissile argillite (Plate 1-6-4). Chert beds are buff-white to light grey to khaki and typically recrystallized. They weather a buff to chalk-white and less commonly maroon. Individual beds vary from 0.5 to 15 centimetres thick but are usually on the order of 1 to 4 centimetres. Argilliceous interbeds are dark grey and range from 0.5 to 1 centimetre in thickness. These interbeds weather preferentially and form recessive bands that impart a ribbed appearance to outcrops.

Plate 1-6-4. Typical weathering appearance of the ribboned chert unit.

The unit is folded in most outcrops. Typically most deformational strain is accommodated by the argillaceous layers and as a result, close to tight similar folds predominate (Plate 1-6-5). Parasitic minor folds are common throughout the unit and are the clearest indication of the vergence and orientation of larger scale structures.

Plate 1-6-5. Folded ribboned chert, exposed along the western shoreline of the North Arm of Stuart Lake.

BEDDED SILTSTONE-SANDSTONE

Thinly laminated and rhythmically interbedded siltstone-sandstone occupies an isolated outcrop area marginal to the Shass Mountain pluton, south of Whitefish Lake. Siltstone layers are light grey to black, variably fissile, and usually form the thinnest laminations in the sections. Individual beds range from wispy crossbeds, less than 1 millimetre thick, in a sandstone matrix, to thicker, often fissile interbeds up to 2 centimetres thick. Biotite is a common accessory mineral and is interpreted to be metamorphic in origin, related to intrusion of the Shass Mountain pluton. Locally the siltstone is siliceous and cherty in appearance giving the rock a light grey colour. These layers are easily distinguished by colour, lack of fissility and more blocky fracture.

Sandstone layers are maroon, buff-weathering, fine to medium-grained quartz wacke. Beds are generally thicker than the siltstone layers and range from 0.5 to 10 centimetres in thickness.

Contacts between the interbeds are sharp, and grading within the individual beds is uncommon. Sedimentary features such as crossbedding and flame structures are common. Locally the bedding is truncated by thick, massive beds of maroon biotite-bearing wacke suggestive of larger scale crossbedding. Finer and larger scale sedimentary structures observed in the unit suggest that it may be turbiditic.

LIMESTONE

Limestone forms a continuous northwest-trending belt 8 to 10 kilometres wide, immediately east of the area mapped (Figure 1-6-2). Locally throughout the map area, it is the only unit with clearly definable contact relationships, occurring most commonly as massive, isolated bodies that sit as blocks or rafts within a matrix of sheared phyllitic argillite or limy mudstone. It is typically recrystallized, weathers a buff-white to light to dark grey to blue-grey and is locally mottled. Blocks range in size from metres (Plate 1-6-6) to hundreds of metres (Plate 1-6-7) to kilometres in size.

Locally, 2 to 5-centimetre grey to buff-white massive limestone layers are interbedded with thinner 1 to 2-centimetre interbeds of tan-brown weathering, limy mudstone-siltstone. In these outcrops the limy mudstone layers are recessive and exposures have a ribbed appearance (Plate 1-6-8).

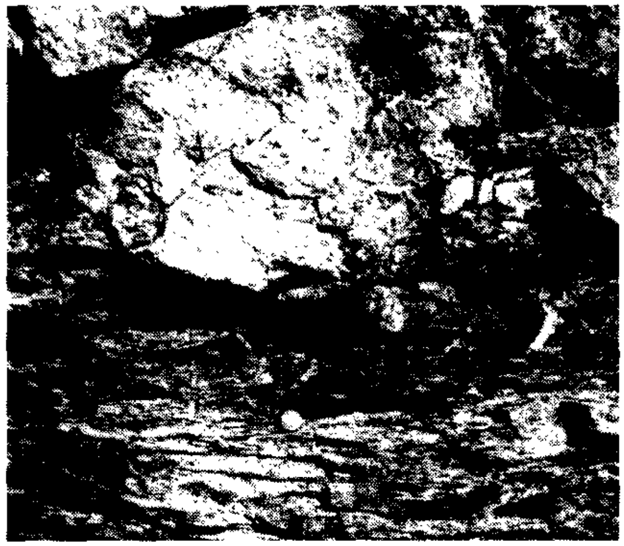

Plate 1-6-6. Massive limestone block within a sheared and flattened, limy mudstone containing small flattened massive limestone lenses.

Plate 1-6-7. Limestone block within sheared phyllitic matrix. Battleship Island, Stuart Lake.

Plate 1-6-8. Bedded limestone with thinner and darker marly limestone interbeds.

OCEANIC CRUSTAL AND UPPER MANTLE ROCKS

Oceanic crustal lithologies include metabasalts and mafic and ultramafic plutonic rocks and occur in close association with one another in four localities in the map area (Figure 1-6-3). All these areas contain the lithologic components of an idealized ophiolite or oceanic crustal section and are best characterized as "ophiolitic remnants" that have been intensely disrupted by folding and faulting during and after terrane collision. These remnants are the dominant unit in the topographically higher, northern part of the map area and along a ridge to the south. The most extensive ultramafic units mapped crop out at the highest topographic elevations. This relationship is interpreted to be a function of an inverted ophiolite stratigraphy produced by structural stacking during obduction of the oceanic lithosphere, however, currently available data are insufficient to prove this relationship.

METABASALT

Metabasalts are found in association with other crustal lithologies and in isolated localities with siliceous pelagic sedimentary rocks.

These rocks are typically grey green, fine grained, aphanitic to less commonly porphyritic and massive, however, brecciated and rare pillowed structures are identified locally. In some exposures the fine-grained aphanitic metabasalt grades into a slightly coarser, lighter weathering rock, representing a diabasic phase of the unit which is in part transitional to the metagabbroic unit described following.

The unit is microcrystalline with a felted texture. It is characterized by 40 to 60 per cent, randomly oriented, subhedral, tabular plagioclase microlites. These grains are variably sericitized and range from 0.1 to 0.5 millimetre in length. Intergranular, finer grained, variably chloritized pyroxene with trace to 2 per cent opaque minerals, forms the remainder of the rock. Augite microphenocrysts vary from subhedral to often euhedral 0.5 to 2-millimetre grains and comprise from trace to 10 per cent of the unit.

Quartz, chlorite, epidote and minor carbonate occur as the vein, vug and fracture filling material. In all but one of the thin sections examined, evidence of deformation is minimal with little or no preferential growth of secondary minerals.

METAGABBRO

Metagabbroic rocks are best exposed along the lake shore and on several islands in the middle arm of Stuart Lake. They also crop out along the eastern ridge of ultramafic rocks to the west of the Snowbird property and form a poorly defined belt between the Ruby Rock ultramafic body and the North Arm of Stuart Lake. Metagabbro in the McKelvey Lake area is confined to a few isolated exposures associated with the ultramafic rocks.

The gabbroic rocks are typically dull grey and weather a tan brown. They are medium to coarse grained, generally equigranular but locally varitextured and comprise roughly equal proportions of mafic and felsic minerals. Mafic minerals include 2 to 4-millimetre anhedral clinopyroxene replaced to varying degrees by secondary amphibole. Relict plagioclase, of similar grain size, is typically completely sericitized.

Mafic minerals in gabbroic rocks adjacent to the Shass Mountain pluton near Mount Nielsp have textures that appear to result from the close proximity of the pluton. Mafic grains are replaced by 1 to 2-millimetre tabular to highly irregular shaped amphibole (relict pyroxene ?). Under cross nicols, individual grains are seen to comprise finer aggregates with a polygonal texture, suggestive of recrystallization.

ULTRAMAFIC ROCKS

The best and most continuous exposure of ultramafic rocks is along the upper levels of a series of northeast-trending ridges that include Mount Nielsp, to the west of the Snowbird property. They also form a continuous belt along the western margin of the McKelvey Lake pluton and are identified over a distance of several 100 metres in a single large cliff exposure near the large gabbro body on the north side of the middle arm of Stuart Lake.

Variably serpentinized and locally carbonatized dunitic to wehrlitic ultramafic cumulates are the most abundant ultramafic rock type. Harzburgite is only identified along the western margin of the Ruby Rock ultramafic body. The unit is black to dark green and weathers tan to dark brown where only moderately serpentinized. Where serpentinization is more complete, surfaces are light to dark grey to grey green with a characteristic mottled appearance. In several localities, incohesive sheared serpentinite has a characteristic anastomozing cleavage fabric.

Thin sections were reviewed only from the ultramafic rocks along the ridge to the west of the Snowbird deposit. These rocks locally preserve relict magmatic poikilitic texture with cumulate olivine and intercumulate pyroxene. Olivine comprises from 80 to 95 per cent of the unit as individual 1 to 3-millimetre euhedral grains which are from 40 to 75 per cent serpentinized. Relict grains form isolated kernels surrounded by mesh-textured antigorite, as serpentinization has developed along fractures. Development of secondary magnetite in association with serpentinization is minor to rare. Relict pyroxene is not preserved, as the intercumulate phase is totally replaced by fibrous aggregates of chlorite and talc. The relict cumulate poikilitic texture is, however, well preserved. Chrome spinel is a minor accessory mineral, comprising less than 1 per cent of the rock. Its habit is highly variable, forming 0.3 to 2-millimetre, anhedral to subhedral grains that are typically found in the altered intercumulate phase.

CARBONATIZED ULTRAMAFIC ROCKS

Carbonatized ultramafic rocks are exposed on the Snowbird property and locally developed marginal to the McKelvey Lake pluton. At the Snowbird property, carbonatized and potassium metasomatized ultramafic rocks occur as slivers or tectonic lenses closely associated with mineralized quartz veins along the Sowchea fault zone. These are buff-cream coloured, rusty orange-brown weathering rocks comprising coarse-grained aggregates of magnesite and quartz that are cut by a network of white dolomite and quartz veinlets. The alteration affecting these ultramafic rocks has completely obliterated any primary minerals and textures which would help to interpret the original protolith.

The extent of carbonate alteration affecting ultramafic rocks along the western margin of the McKelvey Lake pluton is not well established. Carbonatization is most pronounced immediately northeast of McKelvey Lake, in a cliff face 50 to 60 metres high. The effects of carbonate alteration diminish over a distance of approximately 1 kilometre north of this exposure.

INTRUSIVE ROCKS

The Middle Jurassic (165 Ma) Shass Mountain pluton (Ash *et al.*, in preparation) is the largest intrusive body in the region. It is an elongate northwest-trending intrusion exposed between Stuart Lake and Sutherland River (Figure 1-6-2) that metamorphoses oceanic rocks along the western edge of the map area. The western margin of a previously unnamed intrusion, informally referred to here as the McKelvey Lake pluton, crops out along the northeastern edge of the area. It is similar in weathering appearance, texture and mineralogy to the Shass Mountain body.

Isolated, small stocks that are compositionally and texturally similar to both the Shass Mountain and McKelvey Lake plutons are exposed northwest of the North Arm of Stuart Lake and a poorly constrained body crops out east of Whitefish Lake. Small, pervasively metasomatized stocks are identified in two other localities.

The Shass Mountain pluton is a medium to coarse-grained, equigranular white to buff-white weathering tonalite (Plate 1-6-9). The unit varies from being completely isotropic to locally displaying a well-developed flow fabric, most conspicuous near the margin of the body. Orientation of the fabric consistently parallels the intrusive contact and is characterized by a penetrative foliation defined by alignment of mafic minerals (Plate 1-6-10). Mafic xenoliths are also common near the margins of the pluton and include fragments of both hornfelsed sedimentary country rocks and more commonly, melanocratic, medium to coarse-grained amphibole-rich cognate xenoliths. Within undeformed areas of the intrusion, xenoliths are completely angular and range from several centimetres to several tens of centimetres accross. In foliated areas of the pluton, mafic xenoliths are strongly attenuated and visually emphasize the fabric where they are elongated within foliation planes (Plate 1-6-11). Locally, these xenoliths are completely attenuated, giving the unit a banded or striped appearance.

Primary minerals, in decreasing order of abundance, are plagioclase, quartz, amphibole and biotite. Both felsic and mafic minerals show little or no sign of secondary alteration in thin section. Plagioclase occurs as 1 to 3-millimetre, lath-shaped subhedral to euhedral cumulate grains which comprise from 35 to 40 per cent of the rock. Quartz is typically anhedral, comprising from 35 to 40 per cent of the unit and occurs as both isolated 1 to 3-millimetre anhedral grains and as larger 3 to 5-millimetre grains which poikilitically enclose plagioclase, hornblende and biotite. Mafic mineral content locally varies from 15 to 30 per cent. Hornblende which forms 0.5 to 5-millimetre euhedral to subhedral grains is usually the dominant mafic mineral, however, biotite occurs locally in greater abundances.

The mineralogy and preliminary elemental analysis of the pluton supports an I-type classification corresponding to a biotite hornblende tonalite association (Ash *et al.*, in preparation).

METASOMATIZED SATELLITE STOCKS

Two small pervasively metasomatized linear felsic intrusive bodies are known in the map area. A northwest-trending elongate body near the lake shore east of the Snowbird property was mapped by Game and Sampson (1987a, b). The other outcrops as two small, isolated islands in the centre of Stuart Lake.

A finer grain size and a dull brown to flesh-tone weathering appearance clearly distinguish these bodies from the previously described felsic plutonic rocks. Disseminated 2 to 4-millimetre pyrite cubes, varying in abundance from 2 to 4 per cent, produce rusty brown weathering pits on exposed surfaces which are also diagnostic. Preliminary petrographic analysis indicates that secondary sericite and carbonate are also present in addition to pyrite.

The Snowbird stock is an oblong tonalite body, roughly 1 kilometre long and up to 200 metres wide, which intrudes deformed pelagic sediments and metabasaltic rocks between Stuart Lake and the main Snowbird showing (Figure 1-6-3). This intrusion was referred to as the "granite zone" by Faulkner and Madu (1990). This usage is discontinued here as petrographic review combined with potassium feldspar

Plate 1-6-9. Isotropic, equigranular texture of the Shass Mountain pluton.

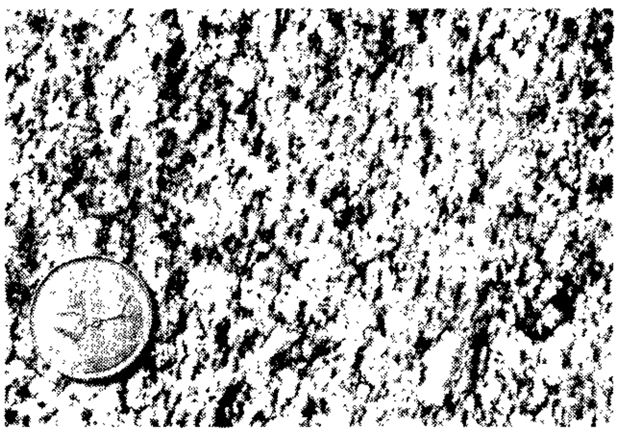

Plate 1-6-10. Alignment of mafic minerals defines a well-developed foliation fabric.

Plate 1-6-11. Strongly attenuated, mafic xenoliths aligned subparallel to foliation in the Shass Mountain pluton.

staining indicates that the intrusion is potassium-deficient and therefore not a granite. Quartz and feldspar occur in roughly equal proportions varying from 40 to 45 modal per cent. Mafic minerals which comprise from 10 to 20 modal per cent of the rock are pervasively carbonatized and weather orange brown.

Preliminary petrological analysis and whole-rock geochemical data for the Snowbird stock suggest that it is compositionally similar to the Shass Mountain pluton 5 kilometres to the west. Argon-argon isotopic analysis of sericite by laser step-heating methods indicates a Middle Jurassic (157 Ma) age of potassium metasomatism (Ash *et al.*, in preparation). This age is interpreted to represent alteration due to the effects of magmatic volatiles during the final stages of crystallization.

STRUCTURE

The map area is dominated by a prominent structural grain that is defined by the subparallel alignment of major structures, characteristic of the Stuart Lake belt as a whole (Armstrong, 1949). The grain trends predominantly to the north and northwest and is typically steeply dipping but locally flattens and rotates to a westerly orientation. This feature is most conspicuous in the centre of the map sheet at the bend in Stuart Lake and suggests that the shape of the lake may be structurally controlled.

Equal-area, lower hemisphere stereographic projections indicate several map-scale trends (Figure 1-6-4). The plots suggest the rocks are folded about subparallel axes that reflect the dominant structural grain. Cleavage and bedding mimic each other in distribution and orientation, striking northwest and dipping southwest and northeast, with moderate southwesterly dips predominating. Bedding-cleavage intersections and axes of small-scale parasitic folds plunge gently to moderately toward the southeast and northwest and are most easily recognized in the pelagic sedimentary sequences. Fold types range from open buckle folds in the thicker, more competent layers, to tight to isoclinal similar folds in the thinner bedded lithologies with the highest competency contrasts. A strong axial planar cleavage is associated with this folding and varies from gently inclined to upright, rotated around northwest-trending axes with changes in the attitude of the folds. Higher order, parasitic folds display characteristic S, M and Z-shapes and are a reflection of the asymmetry of the larger scale structures.

Folding is not as clearly recognizable in the more massive units such as thickly bedded limestone, and the plutonic and volcanic rocks, however, a foliation fabric paralleling the axial planar cleavage of the sediments is common and forms broad zones within these rocks. Similarly, flow fabrics in rocks of the Shass Mountain pluton and related stocks parallel this regional trend.

Discrete zones of intense shearing and foliation development are identified in all units and range in width from centimetres to tens of metres; they are most pronounced in silty layers. These shears locally disrupt bedding, fragmenting individual layers and isolating them as competent blocks within an anastomosing sheared matrix. Shearing appears to be related to folding as these fabrics roughly parallel the axial planar cleavages of the folds and is probably the result

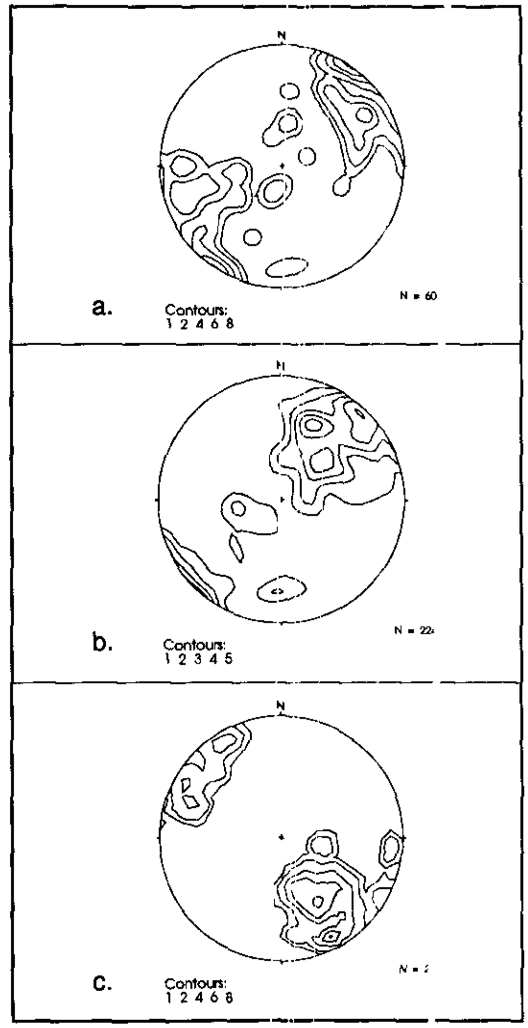

Figure 1-6-4. Equal-area, lower hemisphere stereographic projections of structural data from the Fort St. James map area; (a) plot of poles to bedding; (b) plot of poles to foliation and cleavage; (c) plot of lineations, includes axes of small-scale folds and bedding-cleavage intersections.

of a progressive increase in deformation of the folded layers.

BASALT GEOCHEMISTRY

The major element chemistry of basaltic rocks in the Pinchi Lake area has been presented and discussed previously by Paterson (1973). He established the presence of both alkali and tholeiitic basalts in the area

A total of 25 mafic metavolcanic samples were collected from near Pinchi Lake and within the general vicinity of the Snowbird deposit (Figure 1-6-5). Major and rare-earth element (REE) analyses have been obtained for nearly all the samples collected, but trace element analyses are currently available for only 14 of the samples (Table 1-6-1). These chemical data are used to interpret the paleotectonic setting in which these rocks erupted.

All samples analyzed are basaltic in composition with silica contents varying between 45 and 51 weight per cent

(Figure 1-6-6a) and are divisible into both alkaline and subalkaline suites (Figure 1-6-6b). Trace element discriminant diagrams involving the immobile high field-strength elements (Y, Zr and Nb; Figure 1-6-7a, b and c) indicate that subalkaline and alkaline suites fall into the fields of mid-ocean-ridge (MORB) and within-plate basalts (WPB), respectively. This relationship is also evident on a plot using ratios of more incompatible to less incompatible elements (*e.g.*, Ti/V, Figure 1-6-8). On the titanium *versus* vanadium plot the subalkaline basalts occupy a field which in part overlies the area of overlap between arc-tholiites and MORBs. The range in titanium and vanadium abundances of this suite, however, defines a field which clearly follows the hypothetical fractionation path (solid line) characteristic of MORBs (Shervais, 1982). Alkali basalts have Ti/V ratios greater than 50, consistent with ratios of Hawaiian alkali basalts and suggesting an ocean-island setting.

On a MORB-normalized multi-element plot (Figure 1-6-9) the two suites are clearly distinguished. Alkali basalts are enriched in most of the incompatible elements relative to MORBs. The least incompatible elements (Y and Yb) show no enrichment relative to MORBs while the most incompatible elements (Th, Ta and Nb) show a humped pattern characteristic of within-plate basalts (Pearce, 1982, 1983). More specifically, they show abundance patterns which are indicative of ocean islands and a negative slope between Y and Yb clearly discriminates this suite from E-MORBs (Holm, 1985). The subalkaline suite displays characteristic N-MORB abundances for all the high field-strength elements. Unlike the high field-strength elements which are considered to be generally immobile during hydrothermal alteration or low-grade metamorphism (Cann, 1970; Pearce and Cann, 1973; Pearce, 1983), abundances of the low field-strength or large-ion lithophile elements (Sr, K, Rb and Ba) are highly variable in both suites. The mobility of these elements due to the effects of alteration and metamorphism is well established (Humphries and Thompson, 1978; Pearce 1980, 1982, 1983; Pearce and Cann, 1973; Saunders *et al.*, 1980) and not considered diagnostic. The MORB abundances for thorium, the least

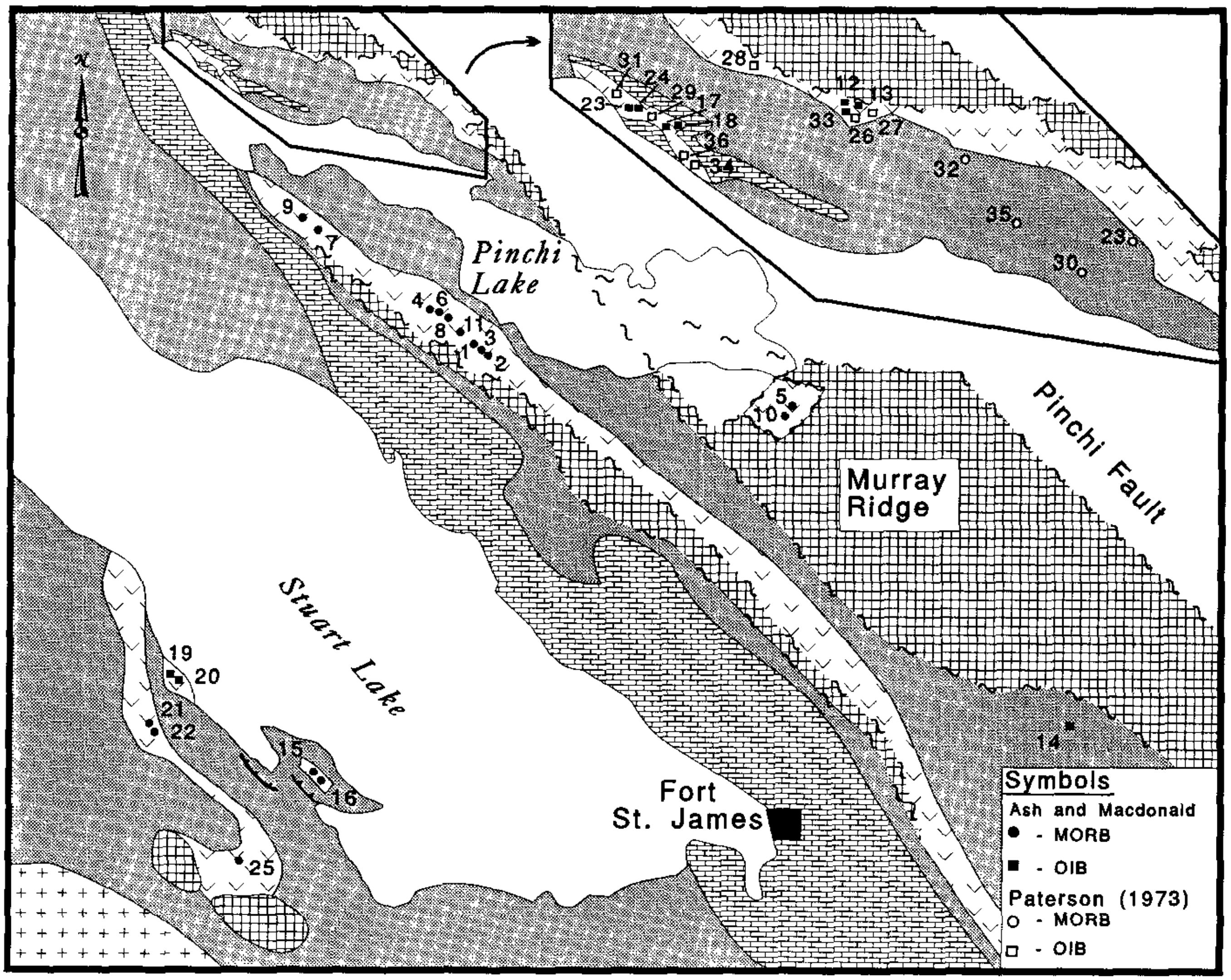

Figure 1-6-5. Generalized geology of the Stuart - Pinchi Lakes area illustrating the locations and geochemical character of sampled metabasaltic rocks. MORB = mid-ocean-ridge basalts, OIB = ocean island basalts.

TABLE 1-6-1
REPRESENTATIVE MAJOR, TRACE AND RARE-EARTH ELEMENT ANALYSES OF METABASALTS FROM THE STUART-PINCHI AREA

Sample	C89-42 02	C89-42 03	C89-42 04	C89-42 05	C89-44 01	R89-13 02-03	R89-14 03	R89-13 02-01	R89-14 04-02	R89-15 02	C89-43 05	C89-46 04	C8[illegible]-46 06	R89-17 03
Location	1	2	3	4	5	6	7	8	9	10	11	12	1[illegible]	14
SiO2	49.48	48.49	49.65	50.97	49.06	49.85	50.19	49.42	49.41	50.13	45.17	48.72	45.60	45.56
TiO2	1.48	1.41	1.66	1.02	0.73	1.55	1.86	1.38	1.50	0.76	2.99	3.69	1.67	3.19
Al2O3	13.91	13.94	13.76	14.32	13.44	13.57	13.07	14.22	14.26	15.41	12.54	12.71	12.34	12.50
Fe2O3	11.94	11.10	12.16	11.53	9.29	13.34	14.23	12.05	12.91	8.99	12.46	12.90	11.20	12.38
MnO	0.16	0.20	0.22	0.19	0.22	0.19	0.26	0.19	0.24	0.19	0.15	0.13	0.12	0.14
MgO	7.30	7.95	6.33	6.14	6.59	9.48	7.32	5.82	7.14	5.93	5.16	4.54	4.58	7.48
CaO	5.38	10.84	9.07	6.75	8.42	5.01	8.29	7.54	9.08	8.76	6.99	7.21	7.75	9.[illegible]
Na2O	4.32	3.42	4.13	3.95	3.10	3.94	3.36	3.16	3.25	3.80	1.98	4.96	2.27	2.41
K2O	1.01	0.34	0.09	0.15	0.98	0.62	0.16	0.88	0.04	0.56	3.22	0.47	3.24	0.84
CO2	0.14	0.22	0.62	0.44	0.73	0.44	0.22	0.25	0.14	1.55	0.65	0.72	0.22	0.[illegible]4
P2O5	0.10	0.11	0.12	0.07	0.11	0.11	0.13	0.10	0.11	0.13	0.43	0.46	0.55	0.44
S	0.01	0.02	0.03	0.06	0.01	0.01	0.15	0.14	0.09	0.28	0.01	0.03	0.01	0.01
LOI	3.61	3.39	2.77	3.76	4.65	3.87	2.36	3.32	3.27	5.44	4.55	3.69	3.90	4.33
Total	98.84	101.43	100.61	99.35	97.33	101.98	101.60	98.47	101.44	101.93	96.30	100.23	[illegible]6.45	99.95
FeO	7.18	6.24	7.13	7.68	5.81	9.97	7.97	8.18	9.11	5.60	6.89	7.89	6.53	8.18
Ni	39	42	39	47	51	25	23	51	25	22	320	195	69	121
Cr	122	192	130	136	313	76	51	146	53	90	389	240	75	211
Ba	56	16	11	29	1436	135	20	117	10	484	262	69	72	114
Sr	81	66	75	96	297	76	101	83	67	356	123	228	134	134
Rb	7	5	10	10	19	10	10	9	10	12	64	13	69	16
Zr	79	82	99	50	62	83	104	76	81	80	254	271	287	258
Y	31	33	39	25	20	36	40	32	34	21	28	32	31	28
Nb	6	7	6	4	5	4	7	4	4	5	31	33	53	36
Cs	3	4	4	4	6	4	4	6	6	5	5	6	6	6
La	7	8	1	4	15	2	9	14	4	15	38	34	46	32
Ce	11	15	18	8	25	17	17	12	23	23	59	61	94	79
V	341	338	353	337	249	361	393	344	362	210	249	250	326	282
Sc	38	42	41	37	40	37	43	40	41	30	27	26	27	31
Hf	1.6	2.2	0.0	1.3	1.6	0.0			0.0		5.9	6.3	6.5	2.0
Ta	0.3	0.3	0.39	0.3	0.3	0.16			0.23		1.6	1.9	3.0	0.3
Th	0.1	0.1	0.2	0.1	1.3	0.2			0.1		2.2	2.2	4.5	1.9
La	2.0	2.6	3.3	1.6	6.3	2.9			3.0		24.2	25.5	39.4	10.0
Ce	7	10	11.0	6	14	9.3			9.4		53	53	79	22
Pr			1.9			1.6			1.6				11.7	
Nd	7	8	10.9	5	8	9.2			9.1		32	32	40	11
Sm	2.1	2.8	3.8	1.7	2.2	3.3			3.4		7.2	7.6	8.2	2.8
Eu	0.80	0.99	1.4	0.65	0.61	1.3			1.3		2.39	2.40	2.70	0.88
Gd			5.1			4.9			4.4				9.2	
Tb	0.6	0.7	0.9	0.4	0.4	0.9			0.8		1.0	1.1	1.3	0.5
Dy			6.27			5.61			5.38				6.61	
Ho			1.30			1.18			1.15				1.08	
Er			3.89			3.52			3.35				2.73	
Tm			0.55			0.52			0.46				0.33	
Yb	2.28	2.90	3.43	2.03	1.42	3.31			3.05		1.75	1.73	1.90	1.60
Lu	0.35	0.43	0.56	0.30	0.22	0.50			0.45		0.24	0.23	0.27	0.25

Sample	CAS91 -71	CAS91 -75	CAS91 -78	CAS91 -79	RMA91 -15-3	RMA91 15-4	RMA91 -15-12	RMA91 -15-13	RMA91 17-1	RMA91 17-2	RMA9 -18-[illegible]
Location	15	16	17	18	19	20	21	22	23	24	25
SiO2	48.62	55.95	46.05	45.52	44.94	50.86	47.33	49.29	46.67	44.80	57.93
TiO2	1.12	1.17	2.47	2.90	2.76	2.55	0.88	1.18	3.60	4.20	0.64
Al2O3	14.42	12.84	10.37	11.33	14.42	13.09	15.19	13.87	12.38	13.61	15.09
Fe2O3	10.66	10.24	12.14	10.79	14.84	13.52	9.86	11.85	11.13	11.80	10.23
MnO	0.19	0.20	0.17	0.14	0.17	0.14	0.16	0.21	0.10	0.12	0.16
MgO	6.80	6.48	10.81	10.17	7.36	5.70	6.05	5.97	7.59	5.67	5.4[illegible]
CaO	7.32	6.39	10.32	10.60	5.20	5.55	11.08	9.09	8.50	9.26	4.34
Na2O	3.70	3.61	1.60	1.41	2.45	2.13	3.51	3.82	2.91	3.52	3.4[illegible]
K2O	0.15	0.15	0.39	0.85	0.11	0.86	0.84	0.79	1.45	1.29	0.2[illegible]
P2O5	*0.09*	*0.09*	0.29	0.32	*0.21*	*0.18*	*0.14*	*0.12*	*0.53*	*0.69*	*0.0[illegible]*
LOI	6.42	2.66	4.64	5.17	6.57	5.13	4.21	3.42	4.42	4.43	2.1[illegible]
Total	99.49	99.78	99.25	99.20	99.03	99.71	99.25	99.61	99.28	99.39	99.6[illegible]
La	2.3	3.7	19.8		11.2	11.1	2.2	2.8	31.1	41.2	1.[illegible]
Ce	7.5	12.8	46.6		30.5	29.1	5.2	6.8	75.4	93.0	4.[illegible]
Pr	1.3	1.7	6.1		4.3	4.0	1.0	1.3	10.0	11.7	0.[illegible]
Nd	7.3	9.0	28.3		21.1	19.5	5.5	7.2	46.4	50.2	4.[illegible]
Sm	2.5	2.9	6.4		5.7	5.3	2.1	2.8	10.0	10.7	1.[illegible]
Eu	0.8	0.9	2.1		1.9	1.8	0.8	1.0	3.2	3.5	0.[illegible]
Gd	3.6	3.8	6.4		6.5	6.0	3.4	4.4	9.7	14.1	2.[illegible]
Tb	1	1	1		1	1	1	1	1	1	[illegible]
Dy	4	5	5		6	5	4	5	6	6	[illegible]
Ho	0.92	1.00	0.86		1.02	0.96	0.92	1.14	1.07	1.04	0.5[illegible]
Er	3	3	2		3	2	3	3	3	2	[illegible]
Yb	2.35	2.53	1.17		1.81	1.73	2.59	2.92	1.76	1.58	1.6[illegible]

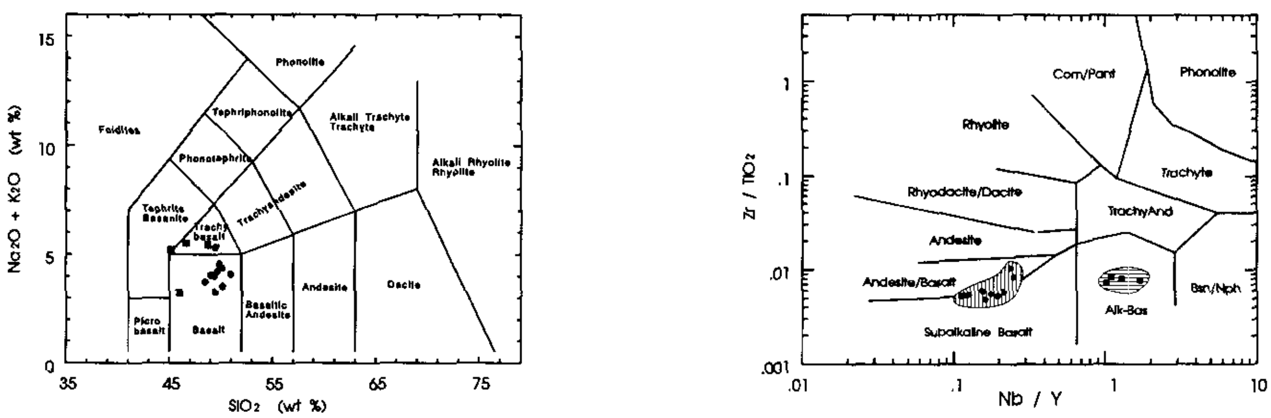

Figure 1-6-6. Classification of metavolcanic rocks from the Stuart - Fort St. James area using (a) Na_2O+K_2O-SiO_2 (after Le Maitre, 1984), and (b) Zr/TiO_2-Nb/Y (after Winchester and Floyd, 1977).

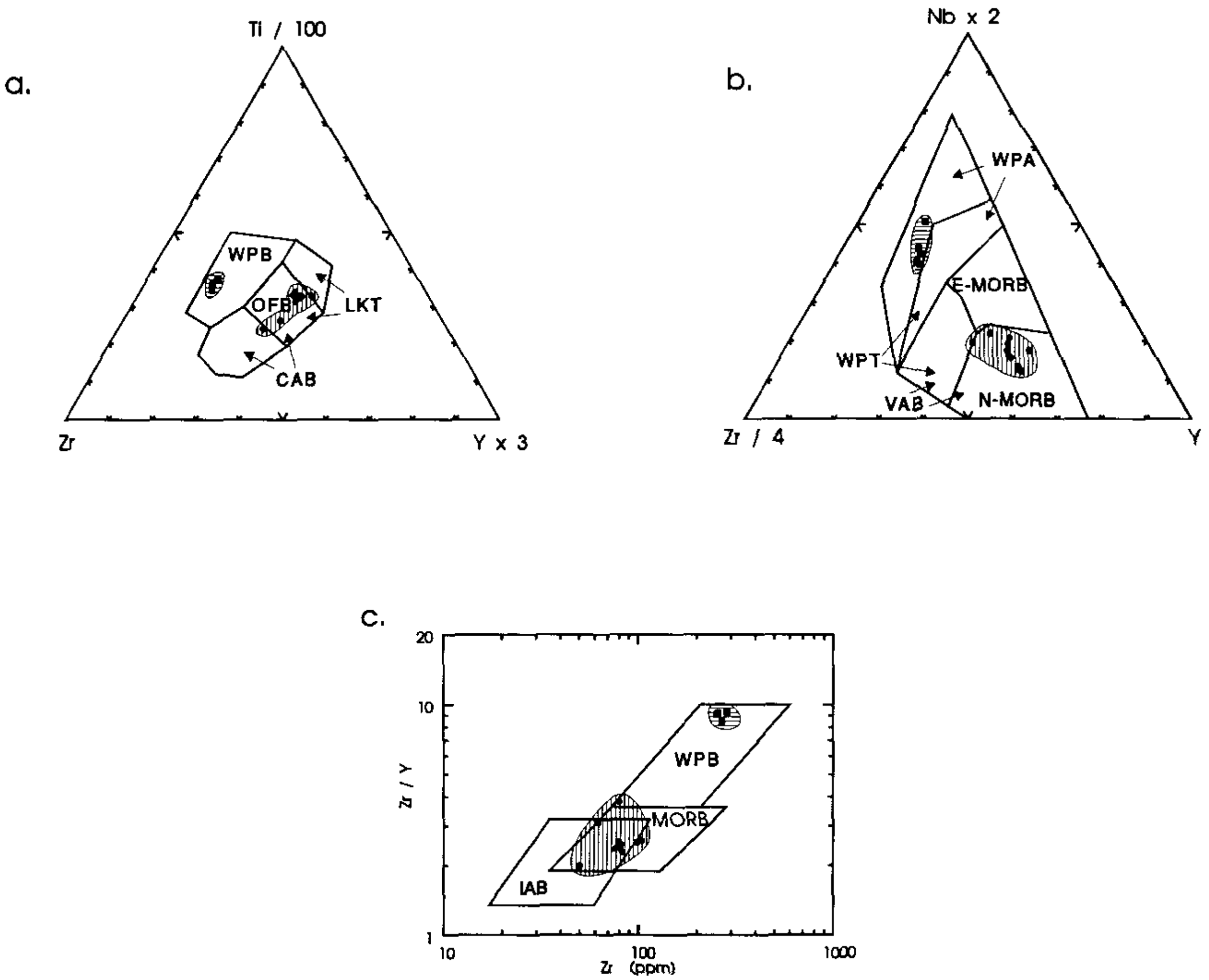

Figure 1-6-7. Trace element discriminant diagrams illustrating fields of metabasalts from the Stuart - Fort St. James area using (a) Ti-Zr-Y (after Pearce and Cann, 1973) (b) Nb-Zr-Y (after Meshede, 1986) and (c) Zr/Y-Zr (after Pearce and Norry, 1979). WPA = within-plate basalts, OFB = ocean-floor basalts, LKT = low-K tholeiites, MORB = mid-ocean-ridge basalts (E = enriched, N = normal), VAB = volcanic arc basalts, IAB = island arc basalts.

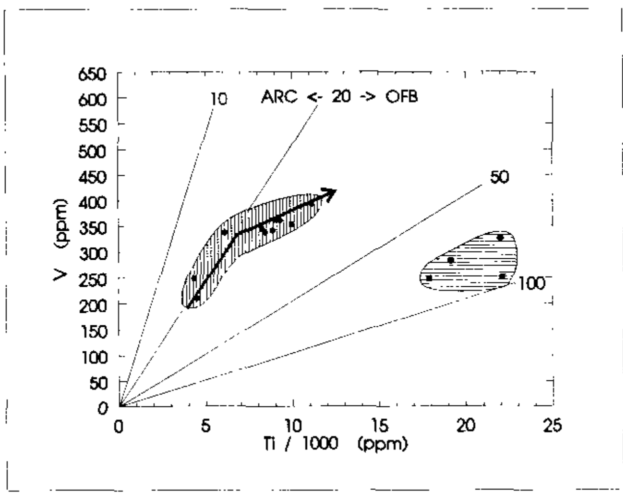

Figure 1-6-8. Plot of Ti vs V, illustrating fields of metabasalts from the Stuart - Fort St. James area (after Shervais. 1982).

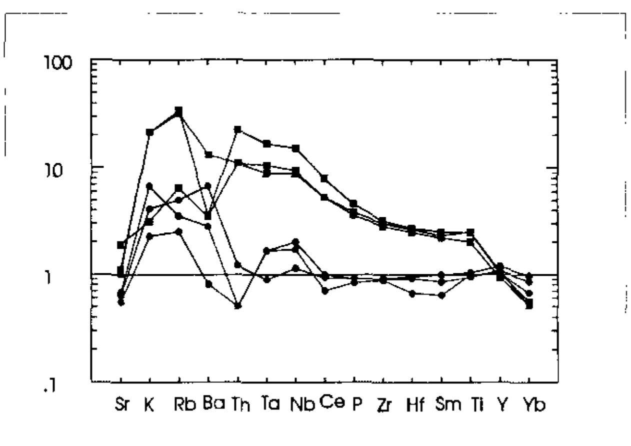

Figure 1-6-9. MORB-normalized multi-element distribution patterns for metabasalts from the Stuart - Fort St. James area. Normalization values from Pearce (1982).

mobile large-ion lithophile element (Wood *et al.*, 1979) are consistently compatible with or lower than N-MORB abundances, suggesting no suprasubduction zone influence.

Subdivisions of the samples for which only major and REE abundances are available (Table 1-6-1) are clearly defined by differences in their REE contents (Figure 1-6-10). The ocean-island suite has a negative slope characterized by light-REE enrichment accompanied by a less pronounced heavy-REE depletion. In contrast the MORB samples display relatively flat to slightly concave upward patterns. The two suites may also be discriminated on the basis of major element content using titanium abundances (Table 1-6-1) as illustrated by Figure 1-6-8. The MORB samples range from 0.73 to 1.86 weight per cent TiO_2 while rocks of ocean-island affinity vary from 2.5 to 5 weight per cent. This difference in TiO_2 abundances was used to subdivide major element analyses presented by Paterson (1973) for the Pinchi Lake area (Table 1-6-2, Figure 1-6-5, inset map).

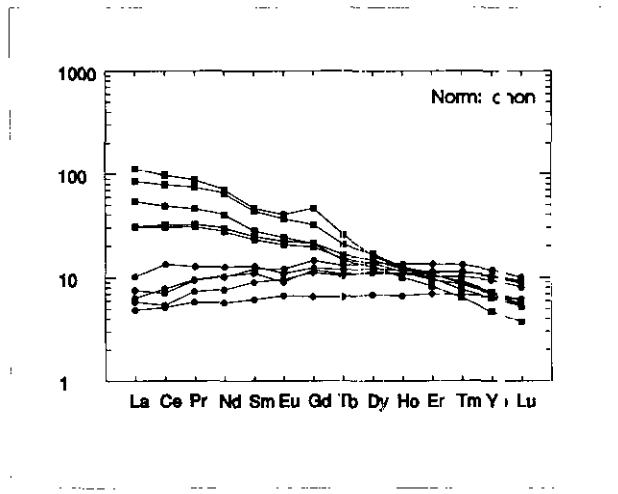

Figure 1-6-10. Chondrite normallized rare-earth elemental abundances of metabasaltic rocks from the Stuart - Fort St. James area. Normalization values from Andrews and Ebihara (1982).

Discussion of Results

Available geochemical data suggest that mafic volcanic rocks in the Pinchi - southern Stuart Lake area record two distinct paleotectonic environments of basaltic volcanism. Regionally, basalts of mid-ocean ridge affinity are most prevalent (Figure 1-6-5). Except for one isolated locality, ocean-island basalts are localized along the Pinchi fault zone, while those of subalkaline composition occur both east and west of the fault and are predominant to the west.

The presence of basaltic rocks with geochemical signatures indicative of ocean islands, primarily along the eastern margin of the Stuart Lake belt in this region, may explain the presence of broad, thick sections of massive, shallow-water limestone. This relationship supports development of carbonate as reefs fringing ocean islands within the Cache Creek ocean, and is consistent with this ocean basin developing at a normal mid-ocean ridge spreading centre. It would clearly be of interest to determine the lateral extent of the ocean-island basalt-limestone association farther north along the eastern margin of the Stuart Lake belt.

MINERALIZATION

As previously indicated, mineral deposits identified in oceanic terranes are found in association with igneous oceanic crust or metamorphic upper mantle rocks. Four isolated areas of oceanic crustal rocks are present in the map area, three of which are not portrayed on the previous geological map of the area (Armstrong, 1949). The Snowbird mesothermal gold-stibnite-quartz-carbonate vein deposit is clearly associated with oceanic ultramafic crustal rocks and the most economically significant.

Snowbird Gold-Stibnite Deposit

The Snowbird deposit (MINFILE 093K 0[illegible]6) is the only significant mineral occurrence known in the map area. It is a shear-hosted mesothermal quartz-carbonate vein deposit,

TABLE 1-6-2
MAJOR ELEMENT CHEMISTRY OF METAVOLCANIC ROCKS FROM THE PINCHI LAKE AREA (From Paterson, 1973)

Location	26	27	28	29	30	30	31	32	33	34	35	36
SiO2	43.80	44.60	44.20	45.60	33.10	32.30	42.90	47.90	42.70	44.80	46.70	47.50
TiO2	4.35	2.72	3.36	3.22	1.75	1.63	5.51	1.49	1.20	4.00	1.49	3.64
Al2O3	14.70	13.10	18.10	13.70	9.10	9.20	10.50	14.40	13.80	16.40	14.10	14.60
Fe2O3	3.90	5.00	3.10	5.60	5.20	5.00	4.20	4.10	4.40	5.20	5.10	3.60
FeO	9.60	6.70	6.80	6.30	4.30	4.30	8.10	7.80	5.50	5.20	7.00	7.60
MnO	0.13	0.16	0.18	0.17	0.20	0.21	0.11	0.14	0.10	0.06	0.14	0.13
MgO	4.50	7.20	3.00	5.40	6.20	6.00	7.30	5.60	7.00	4.40	7.50	4.90
CaO	6.50	9.50	8.60	9.80	20.00	21.00	11.10	7.90	13.80	8.80	9.20	8.90
Na2O	4.80	2.00	5.10	2.60	3.20	3.10	2.90	2.90	1.10	2.70	1.90	3.30
K2O	0.10	2.60	0.30	0.80	1.30	1.40	0.10	0.20	0.20	1.70	0.10	0.80
P2O5	0.56	0.28	0.36	0.37	1.29	2.14	0.08	0.13	0.11	0.17	0.11	0.46
CO2	0.80	0.60	0.70	0.30	9.20	10.40	0.80	1.20	4.00	0.10	1.30	0.10
H2O	4.70	4.30	4.60	4.50	3.90	3.80	4.80	5.10	6.00	5.70	6.60	5.00
Total	98.40	98.80	98.40	98.40	98.70	100.50	98.20	98.90	99.90	99.10	101.20	100.50

located 10 kilometres west of Fort St. James at the southeastern end of Stuart Lake, several hundred metres inland from a small peninsula.

The geology of the Snowbird-Sowchea area has been mapped and in part compiled at a 1:10 000-scale (N. Callan, personal communication, 1992). The area of the main showing has been mapped in greater detail (Heshka, 1971; Game and Sampson, 1987a, b). Previous published descriptions of the deposit include those of Armstrong (1949), Faulkner (1988) and Faulkner and Madu (1990). Fluid inclusion and isotope data on mineralized quartz-carbonate veins have been presented by Madu *et al.* (1990).

The early history of the deposit, as briefly reviewed below, is taken from Armstrong (1949). The property was first staked in 1920 and initially referred to as the McMullen Group; it has obtained its current name from the Snowbird claim block covering the main showing (Plate 1-6-12). It was mined for antimony between 1939 and 1940, producing roughly 77 tonnes of hand-picked ore grading 60 per cent antimony. Mine development during that period included the sinking of a 45-metre inclined shaft and an unknown amount of drifting. The property was dormant from 1940 until 1963 when exploration aimed at determining its gold potential was first undertaken. This work is summarized in assessment reports filed with the British Columbia Ministry of Energy, Mines and Petroleum Resources (Poloni, 1974; Heshka, 1971; Dewonck, 1980; Game and Sampson, 1987a, 1987b).

VEIN MINERALIZATION

Mineralized veins are hosted by the Sowchea shear zone (Armstrong, 1949), a prominent northwest-trending fault zone which dips from 40° to 50° to the northeast. The character and orientation of this structure are well constrained by both drill-hole data (Poloni, 1974; Dewonck, 1980; Game and Sampson, 1987a, b) and excellent surface exposure. The southwest-facing slope of a ridge has been completely stripped of overburden and provides a near continuous exposure of the vein system. Information from assessment reports indicates that 57 diamond-drill holes totalling roughly 5000 metres have been drilled on the property. All drill holes were collared in the hangingwall of the Sowchea shear zone and the vein system. The fault zone

Plate 1-6-12. Adit on the Main vein at the Snowbird showing.

is up to several tens of metres wide and characterized by intense carbonatization, brecciation and shearing. Armstrong (1949) interpreted the structure as: "a zone of faulting, shearing and brecciation that provided channelways for later carbonatizing and mineralizing solutions". We fully support this interpretation. Pervasively carbonatized ultramafic rocks and mafic volcanic rocks occur as tectonic slivers within intensely sheared graphitic and variably pyritized argillite.

Ore shoots at the Snowbird deposit are hosted by three quartz-carbonate±mariposite and/or illite veins, the Main, Pegleg and Argillite veins. Both the Main and Pegleg veins are structurally controlled by the Sowchea fault zone. The Argillite vein follows a high-angle cross-fault perpendicular to the main shear zone. Vein minerals include gold, stibnite, arsenopyrite, chalcopyrite and pyrite. Stibnite is the dominant sulphide mineral, occurring as a massive, grey, fracture-filling phase. Other sulphide minerals are only sporadically developed and a minor component of the vein mineralization. The Argillite vein is reported (Armstrong, 1949) to have carried a body of massive stibnite 10 metres long by 10 centimetres wide that was mined out by the Consolidated Mining and Smelting Company of Canada, Limited during the short life of the mine. The outcrop of the Main vein contains a lens of massive stibnite 4 centimetres wide.

Significant gold values, assayed in drill core, are consistently from vein intercepts along the shear zone, either within, or adjacent to quartz-carbonate-mariposite-altered ultramafic or volcanic rocks. Gold values are highly erratic, with no definable continuity, a characteristic of bonanza style deposits. Game and Sampson (1987a) report that significant gold intersections on the main vein are all associated with massive stibnite. One 10-centimetre intersection of the Main vein, in contact with listwanite, contained visible gold and assayed 8500 grams per tonne gold and 2900 grams per tonne silver.

Fluid inclusion studies on the quartz-gold-stibnite veins (Madu *et al.*, 1990) suggest that the veins were formed from low-salinity, CO_2-rich aqueous fluids at temperatures greater than 240° C and in excess of 80 000 kilopascals (0.8 kilobar) pressure. As such, they fit into the global class of mesothermal vein deposits as defined by Bohlke (1989).

Argon-argon isotopic analysis of mariposite by laser step-heating methods on two samples of listwanite wallrock of the Main vein indicate that the age of carbonate alteration, and presumably gold mineralization, is Middle Jurassic, between 162 and 165 Ma (Ash *et al.*, in preparation). Based on the lithotectonic setting, and the age of the veins and spatially associated felsic intrusive rocks (Figure 1-6-11), it is proposed that vein minerals were precipitated from fluids generated by crustal thickening through partial melting, magmatism and metamorphic devolatization during Middle Jurassic collision. Obduction of oceanic lower crustal and upper mantle lithologies provided deep through-going crustal fault zones active during the collisional event, most critically, during the period of fluid generation and mobilization.

Mineral Potential

The only known mineral occurrence in the Stuart Lake area is the Snowbird deposit described previously. No other significant showings were noted during the coarse of mapping, however, an area of intensely carbonatized ultramafic rocks was identified to the east of McKelvey Lake, adjacent to the contact of the McKelvey Lake pluton in the northwest corner of the map area. Intense carbonatization with associated mariposite and minor 2 to 10-centimetre barren quartz veins together with carbonatized and pyritized felsic dike rocks were identified in numerous large angular boulders at the base of 40 to 50-metre cliff face several hundred metres to the northeast of the lake. The extent of the alteration zone in this area is not well constrained and deserves closer examination.

Potential for mineral occurrences in the northeastern sector of the map sheet cannot be ruled out as the area is heavily mantled with overburden and received only limited coverage, yet it has tectonic and lithologic characteristics conducive to gold-quartz vein mineralization.

We suggest that the lack of known mineral occurrences in the pelagic sedimentary rocks that dominate the central part of the map area reflects the lack of oceanic crustal and upper mantle "ophiolitic remnants" in the area.

The few quartz veins scattered throughout the map area are typically bull white with no visible mineralization. Several of the larger veins were sampled for gold and base metals. Assay results are not available at the time of writing of this report. Samples locations and assay results are tabulated on Open File Map 1993-9 (Ash *et al.*, 1993).

A number of gossanous zones were also identified and sampled. A zone of gossanous hornfelsed sediments adjacent to the Shass Mountain pluton, approximately 4.5 kilometres west-southwest of Mount Neilsp, is roughly 20 to 30 metres wide along a linear topographic trough that parallels the intrusive contact. The sediments are variably silicified and carry from 1 to 4 per cent finely disseminated sulphides, primarily pyrite.

A gossanous, brittle fault zone cuts an isolated cliff exposure of quartz diorite to the northeast of McKelvey Lake. It trends north-northeast, dips steeply and is possibly

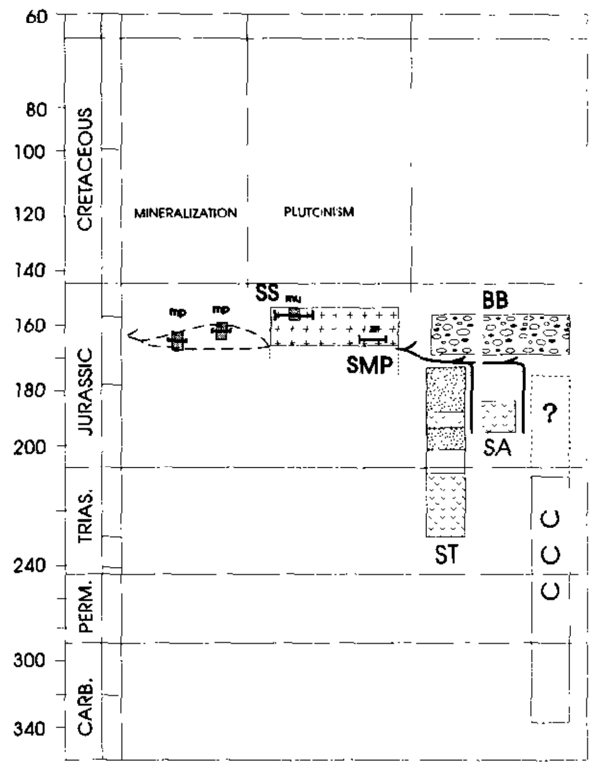

Figure 1-6-11. Geochronology of tectonism, mineralization and plutonism for the Snowbird gold-stibnite deposit.

CCCT – Central Cache Creek Terrane (Orchard 1991; Cordey *et al.*, 1991)
SAC – Stuhini arc complex (Tipper, 1984; L. Diakow, personal communication)
BB – Bowser basin (Currie, 1984)
SA – Sitlika assemblage (Paterson, 1974; Thorstad and Gabrielse, 1986)
SMP – Shass Mountain pluton (Ash *et al.*, in preparation)
SS – Snowbird stock (Ash *et al.*, in preparation)
zr – Zircon
mp – Mariposite
mu – Sericite
All mica ages are by ^{40}Ar-^{39}Ar.

up to several tens of metres wide; however, the limonite staining with associated trace pyrite is only 1 to 2 metres wide at the centre of the zone.

CONCLUSIONS

Regional geological mapping in the Stuart Lake area has established a geographic distribution of oceanic crustal and uppermost mantle "ophiolitic remenants" which are important to the development of mineral deposits in oceanic terranes. The only significant mineral occurrance, the Snowbird deposit, is spatially associated with one such ophiolitic remnant at the southern end of the map area. A lack of mineral occurrences in the lower lying central part of the map sheet is considered to be lithologically controlled and reflects the dominance of pelagic sediments and lack of ophiolitic remnants in the region. An increased abundance of oceanic crustal and upper mantle lithologies in the northern part of the map area suggests a higher mineral potential. A knowledge of the distribution of such remnants within the largely sedimentary Cache Creek Terrane is therefore necessary to adequately evaluate its mineral potential.

Combined geochemical data, petrographic analysis and potassium feldspar staining of felsic intrusions throughout the map area suggests that they are compositionally similar and are interpreted to have been intruded during a Middle Jurassic magmatic event which immediately followed emplacement of the oceanic terrane.

Geochemical data from mafic volcanic rocks in the Stuart-Pinchi area indicate that basalts of both mid-ocean-ridge and ocean-island affinity are present. Ocean-island basalts are concentrated along the eastern margin of the Stuart Lake belt and provide a reasonable explanation for the presence of thick sections of limestone along the belt. This interpretation clearly supports Monger's (1975) conclusion regarding the presence of shallow-water limestones in the Cache Creek Terrane of northwestern British Columbia.

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