Preliminary geology of the Quill Creek map area, southwest Yukon parts of NTS 115G/5, 6 and 12

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ABSTRACT

Geologic mapping within the Quill Creek area identified complex stratigraphic and structural relationships that characterize much of the Kluane Ranges in southwest Yukon. Bedrock in the Quill Creek area consists of Late Paleozoic to mid-Mesozoic volcanic and sedimentary rocks belonging to the Wrangellia Terrane. These rocks are intruded by Upper Triassic mafic and ultramafic sills and dykes and Early Cretaceous to Oligocene granitic rocks. At least two phases of folding are recognized that affect rocks throughout the mapped area. Early phase folds are likely associated with large, low-angle thrust faults. Reactivation of thrusts during younger strike-slip faulting may be responsible for refolding of the early folds.

Several known mineralized showings occur within the Quill Creek area, including extensive nickel-copper-platinum group element mineralization associated with the ultramafic sills. Samples collected during 2004 mapping indicate potential for copper-silver mineralization at the base of Upper Triassic volcanic rocks.

RÉSUMÉ

La cartographie géologique de la région de Quill Creek a permis de mettre en évidence des relations stratigraphiques et structurales complexes qui caractérisent une bonne partie des chaînes Kluane dans le sud-ouest du Yukon. L'assise rocheuse de la région de Quill Creek est formée de roches volcaniques et sédimentaires qui datent de la période allant du Paléozoïque tardif au Mésozoïque moyen et appartiennent à la Wrangellie. Ces roches sont pénétrées par des filons-couches et dykes mafiques et ultramafiques du Trias supérieur et des roches granitiques de la période allant du Crétacé précoce à l'Oligocène. Au moins deux phases de plissement ont touché les roches dans l'ensemble de la région cartographiée. Les plis de la première phase sont sans doute associés à de grandes failles chevauchantes à faible pendage. La réactivation du chevauchement lors de la formation de failles décrochantes pourrait avoir causé le replissement des plis initiaux.

Plusieurs indices minéralisés sont connus dans la région de Quill Creek, y compris des minéralisations importantes en nickel, en cuivre et en éléments du groupe du platine, lesquelles sont associées aux filons-couches ultramafiques. Les échantillons recueillis en 2004 indiquent la possibilité de minéralisation en cuivre et en argent à la base des roches du Trias supérieur.

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INTRODUCTION

This paper presents preliminary results from 1:50,000-scale bedrock mapping within the Quill Creek area, southwest Yukon. Work completed in the summer of 2004 sets the groundwork for a multi-year project within the Kluane Ranges with the aim of deciphering complex geologic relationships found in Late Paleozoic to Tertiary sedimentary and volcanic rocks associated with the Wrangellia Terrane and younger overlap assemblages. Mapping began in June 2004 and focused on the area between the Donjek River and Burwash Creek (Fig. 1) and is meant to build on data collected by previous workers. A study by Greene et al. (this volume) will focus on the Upper Triassic volcanic rocks of the Wrangellia Terrane and will help to place these rocks within the regional tectonic framework for the Quill Creek area and the surrounding Kluane Ranges.

PREVIOUS WORK

Exploratory geological mapping of the Kluane Ranges and surrounding regions was first conducted by McConnell (1905) and later by Cairnes (1915) and Sharp (1943) within the White River and Steele Creek areas, respectively. In 1951, nickel-copper mineralization was discovered along

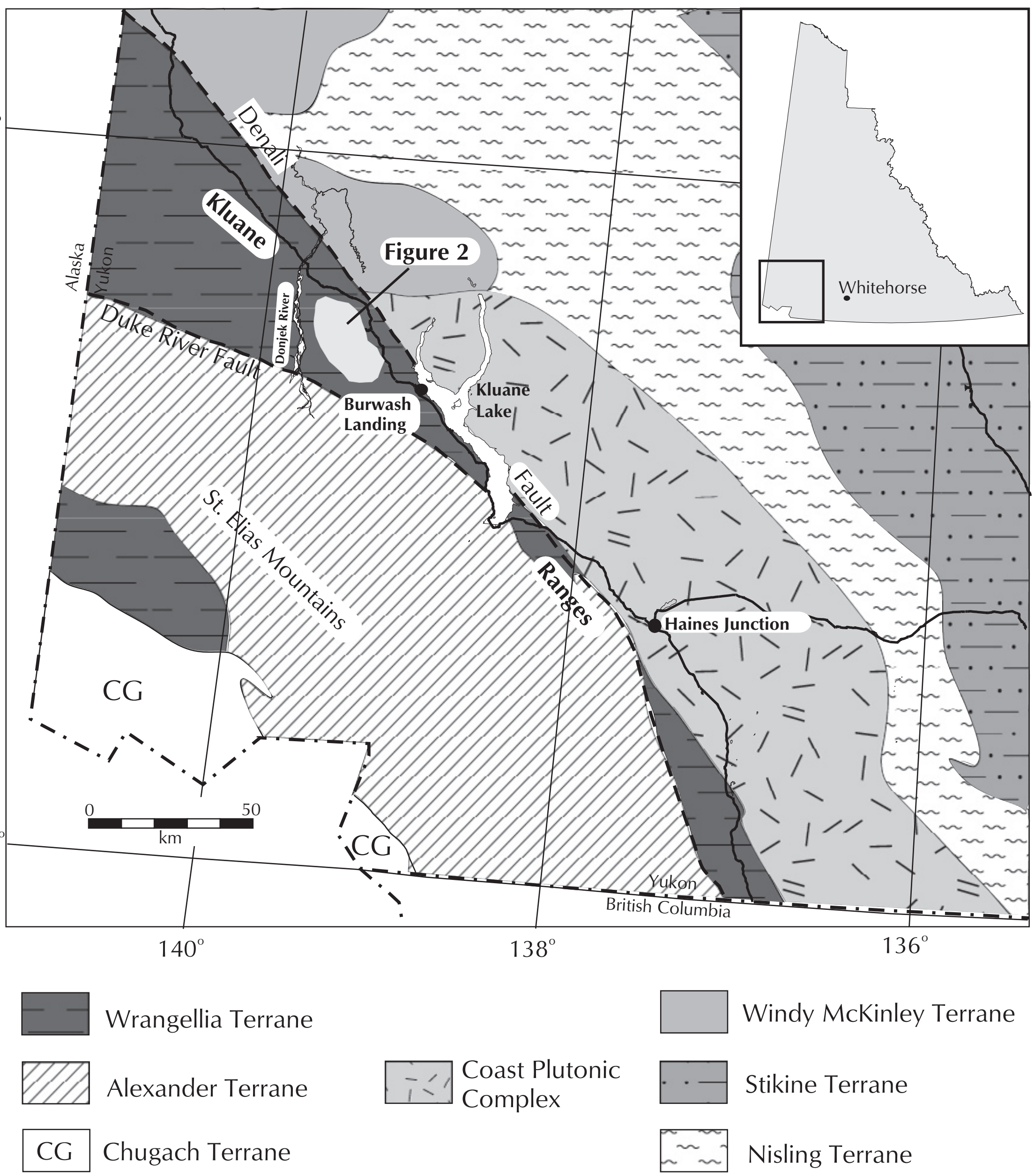


Figure 1. *Terrane map of southwest Yukon, showing the distribution of the Wrangellia Terrane. The location of Figure 2, the Quill Creek map area, is highlighted for reference (after Wheeler et al., 1991).*

Quill Creek. This led to a staking rush and an increase in industry activity that was followed by the preliminary geological investigations of Bostock (1952). Subsequent regional mapping of parts of the southwest Dezadeash (Kindle, 1953), southwest Kluane Lake (Muller, 1967), Tatshenshini (Watson, 1948) and Mount St. Elias (Wheeler, 1963) map sheets was carried out by the Geological Survey of Canada (GSC). Between 1973 and 1987, the GSC mapped the entire St. Elias Mountains, including the Kluane Ranges, at a scale of 1:250 000 under the auspices of Operation St. Elias. The objective of this project was to gain a better understanding of an area for which limited geological information existed. Several reports were produced from this study including a summary of the pre-Cenozoic rocks of the Kluane and Alsek ranges (Read and Monger, 1976), an investigation of the Ni-Cu mineralization within the Kluane Ranges (Campbell, 1976) and 1:250 000 compilations of bedrock geology for 115 A, 115 B/C, 115 G/F and 114 P (Dodds and Campbell, 1992). Detailed investigations of ultramafic intrusions associated with Ni-Cu-PGE mineralization in the Kluane Ranges by Hulbert (1997) led to identification of the 'Kluane mafic-ultramafic belt,' which underlies the Kluane Ranges from southern Kluane Lake to the Alaska-Yukon border. Geologic mapping of the Quill Creek and surrounding area accompanied this project (T. Bremner, unpublished data).

GEOLOGIC SETTING

The Kluane Ranges are composed of Late Paleozoic to Middle Mesozoic rocks of the Wrangellia Terrane and portions of the Alexander Terrane, and younger Mesozoic to Cenozoic overlap assemblages. The Wrangellia Terrane and the Alexander Terrane were amalgamated prior to Middle Jurassic, and perhaps as early as Pennsylvanian time, to form the Insular Superterrane. This large composite terrane spans much of the western margin of the North American Cordillera from Vancouver Island to southern Alaska (Gardner et al., 1988; Gehrels, 2002) and was accreted to the North American margin by at least the Middle Jurassic (McClelland et al., 1992; van der Heyden, 1992; Gehrels, 2001; Ridgeway et al., 2002). Late Mesozoic and Cenozoic dextral strike-slip faulting along the Denali and related faults dissected the amalgamated terranes and offset portions of the terranes by as much as 350 to 400 km (Lowey, 1998). This event included reactivation of the Wrangellia/Alexander suture, now defined in southwestern Yukon by the Duke River Fault (Fig. 1). The Wrangellia Terrane in the Kluane Ranges forms a fault-bounded wedge that widens to the northwest and is juxtaposed against the Coast Plutonic complex along the Denali Fault to the northeast and against the Alexander Terrane along the Duke River Fault to the southwest (Fig. 1).

The Quill Creek map area is underlain entirely by rocks of the Wrangellia Terrane. It contains much of the Late Paleozoic to Upper Triassic stratigraphy that defines the terrane.

STRATIGRAPHY

SKOLAI GROUP

Pennsylvanian to Lower Permian volcanic and sedimentary rocks of the Quill Creek area have been correlated with the Skolai Group of eastern Alaska (Read and Monger, 1976) where it is divided into a lower volcanic unit, the Station Creek Formation, and an upper sedimentary unit, the Hasen Creek Formation (Smith and MacKevett, 1970). The Skolai Group consists of the Late Paleozoic 'Skolai arc' with the Station Creek Formation representing arc volcanism and the Hasen Creek Formation representing the basin infill during arc subsidence (Nokleberg et al., 1994).

Station Creek Formation

The Station Creek Formation outcrops extensively throughout the Quill Creek area where it is gradationally overlain by rocks of the Hasen Creek Formation and is locally in fault contact with the Upper Triassic Nikolai formation (Fig. 2). Thickness of the Station Creek Formation is unknown since the only exposures of its base are fault contacts (Smith and MacKevett, 1970; Read and Monger, 1976). Outcrops of the Station Creek Formation on the northern slopes of the Kluane Ranges, within the northwestern portion of the Quill Creek area, suggest that it is at least several hundred metres thick. Read and Monger (1976) suggest the unit could be upwards of 3000 m thick in places. Structural complexities, however, likely affect the accuracy of these estimates.

At its type section, within the McCarthy Quadrangle of eastern Alaska, Smith and MacKevett (1970) divide the Station Creek into a lower volcanic flow-dominated member and an upper volcaniclastic-dominated member. In the Quill Creek area the volcaniclastic member dominates with only local exposures of volcanic flows. Volcanic breccia, tuff and tuffaceous sandstone make up the majority of rock types within the Station Creek

Formation in the study area (Fig. 3). The breccia is composed of dark to light green, angular to subangular clasts within a tuffaceous to sandy matrix (Fig. 4a). The clasts are up to several tens of centimeters in diameter and are mainly composed of pyroxene-±plagioclase-phyric basalt and minor light green tuff. The breccia is generally clast-supported but locally shows grading to become more matrix-supported. The tuff is much more variable, ranging from a light green, very fine-grained vitric tuff to a light grey/green coarse-grained crystal rich, volcaniclastic sandstone. Flows composed of pyroxene-±plagioclase-phyric basalt constitute a minor portion of the Station Creek Formation within the study area; however, where they do occur they make up a substantial portion of the outcrops. Campbell (1981) included a 'Transition Zone' within the uppermost Station Creek Formation that consists of argillite, limestone and chert. The Transition Zone marks the gradational boundary

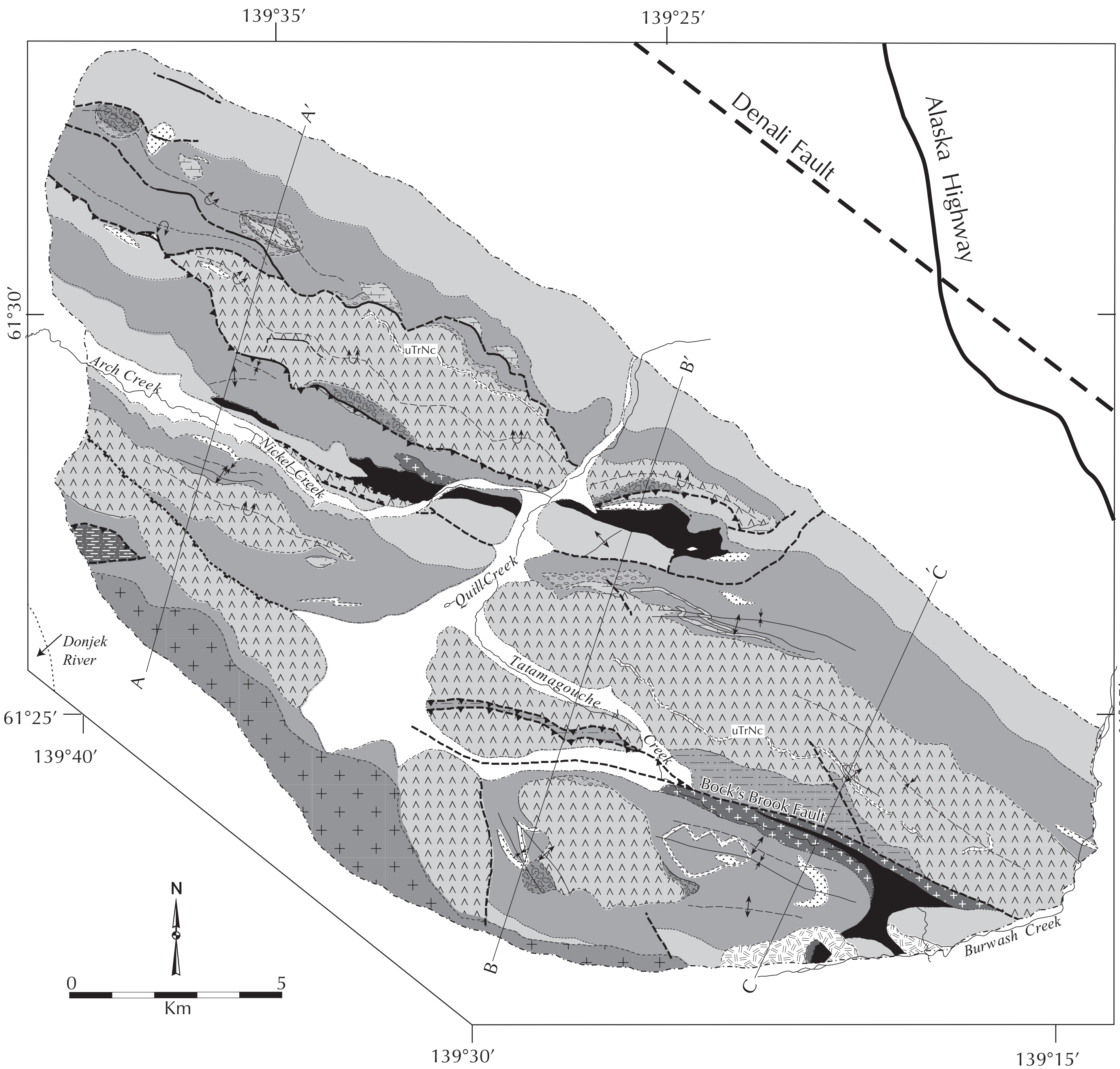


Figure 2. *Generalized geological map of the Quill Creek area (after Israel and Van Zeyl, 2004).*

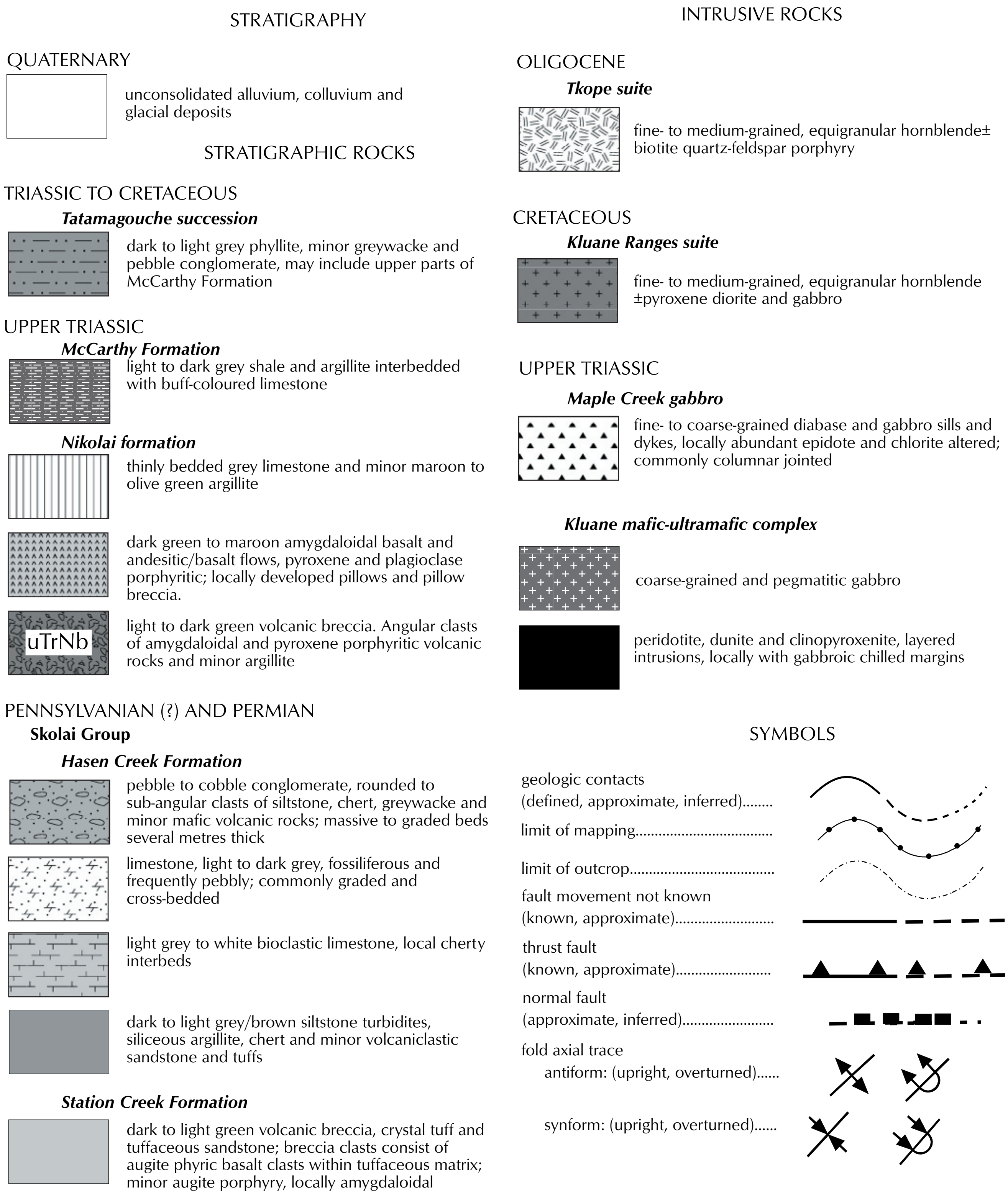
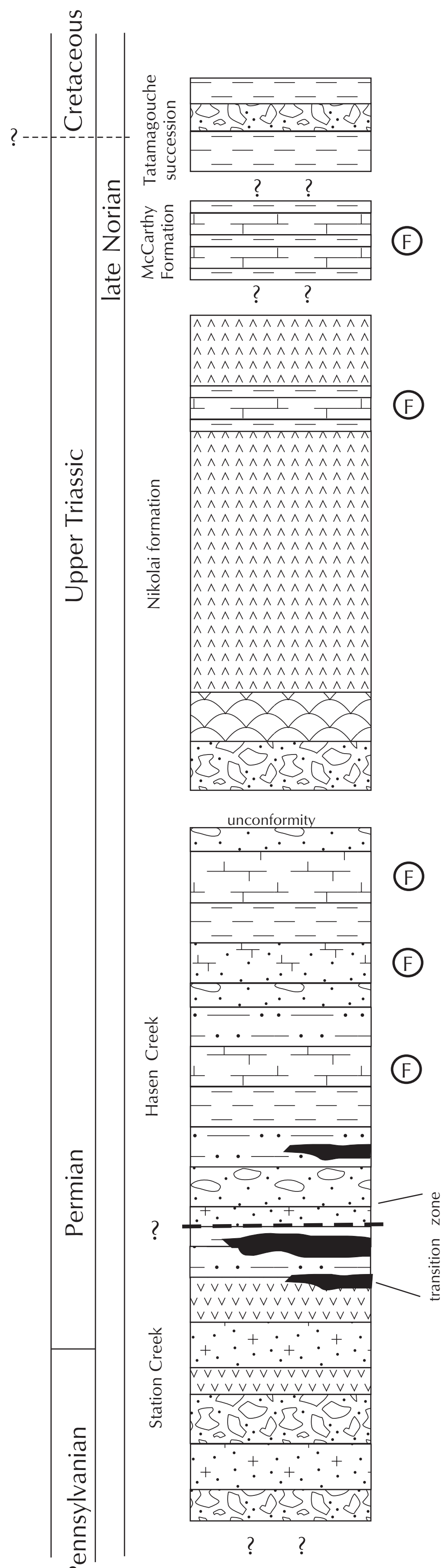


Figure 2. *Legend for Quill Creek map area, facing page.*



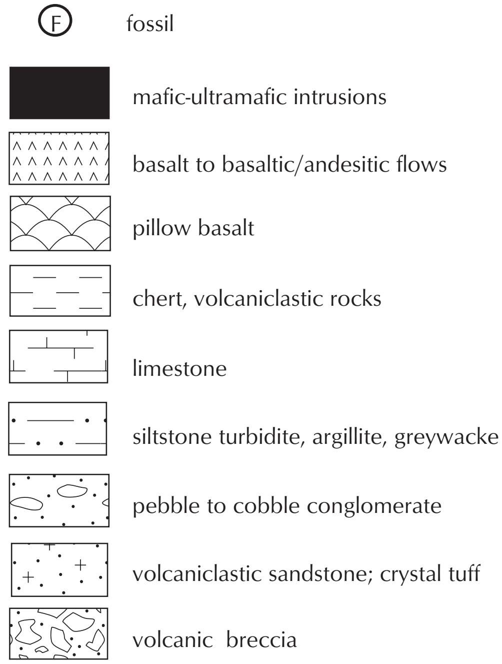


Figure 3. *Schematic stratigraphic column of the rocks found within the Quill Creek map area.*

between the Station Creek Formation and the Hasen Creek Formation.

The age of the Station Creek Formation is not well constrained. Conodonts from the Transition Zone suggest an Upper Mississippian to Early Permian age for the upper part of the unit. In the Wrangell Mountains of east-central Alaska; granitic rocks that intrude the Station Creek Formation and part of the Alexander Terrane have a U-Pb zircon age of 309±5 Ma (Gardner et al., 1988).

Hasen Creek Formation

The Hasen Creek Formation is widespread in the Quill Creek area. It forms the upper sedimentary-dominated portion of the Skolai Group and gradationally overlies rocks of the Station Creek Formation. It is unconformably overlain by the Upper Triassic Nikolai formation. Estimates for the thickness of the Hasen Creek formation range from 300 m to at least 900 m (Smith and Mackevett, 1970; Read and Monger, 1976; Campbell, 1981) and are based upon the placement of the lower contact, the position of which is laterally variable, above the uppermost exposure of Station Creek Formation volcanic rocks.

Figure 4. ***(a)*** *Angular to sub-angular clasts of pyroxene-phyric basalt within volcanic breccia of the Station Creek Formation;* ***(b)*** *Pebbles to cobbles of siltstone, chert and limestone within conglomerate of the Hasen Creek Formation;* ***(c)*** *Typical large outcrop of limestone within the Hasen Creek Formation; outcrop is approximately 40 m high.*

In the Quill Creek area, the Hasen Creek Formation is dominated by siltstone, argillite and greywacke turbidite with local development of conglomerate, limestone, chert and minor volcaniclastic rocks (Fig. 3). Turbidites locally exhibit complete Bouma sequences with graded and cross-bedded layers indicating way-up. Massive argillite beds are also widespread and are up to several metres thick. Conglomerate beds are less than 1 m to >100 m thick and are composed of pebbles to cobbles of siltstone, chert and limestone within a fine- to medium-grained sandy matrix (Fig. 4b). Light beige to white weathering limestone and dark grey limestone conglomerate occur as small lenses and as thick, laterally continuous beds in the upper half of the Hasen Creek Formation (Fig. 4c). They commonly contain solitary and colonial corals and cherty interbeds. Rare beds of volcanic breccia are several metres thick and contain angular to subangular clasts of fine-grained mafic volcanic rocks. Numerous fossils found within the unit suggest an Upper Carboniferous to Lower Permian age for the Hasen Creek Formation (Dodds et al., 1993).

Niklolai formation

The Nikolai formation is an informally named sequence of volcanic and minor sedimentary rocks also known as the Nikolai Greenstone and the Nikolai volcanics (Smith and Mackevett, 1970; Read and Monger, 1976; Campbell, 1981; Dodds and Campbell, 1992). The formation outcrops extensively within the study area, capping many of the highest mountains in the region and coring large regional overturned synclines (Fig. 2). In the Quill Creek area, the Nikolai formation unconformably overlies rocks of the Skolai Group and has uncertain contact relationships with overlying rocks of the McCarthy Formation and the Tatamagouche succession (Fig. 3). The Nikolai formation is up to 1000 m thick in the Quill Creek area and elsewhere is reported to be at least 4350 m thick (Nokleberg et al., 1994). It is a dominantly volcanic sequence that is part of a large oceanic plateau (Richards et al., 1991) that extends to the northwest into Alaska and as far south as Vancouver Island. In the Quill Creek area the Nikolai formation is divided into three units: a lowermost breccia unit (uTrNb), a middle flow unit

Figure 5. ***(a)*** *Volcanic breccia/agglomerate found at the base of the Nikolai formation; note large clast left of hammer;* ***(b)*** *Pillow breccia near the base of Nikolai formation;* ***(c)*** *Poorly formed pillows found at the base of thick flows of the Nikolai formation;* ***(d)*** *Typical flows found within the main volcanic package of the Nikolai formation; note the concentration of amygdules at the top and bottom of flows;* ***(e)*** *Thinly bedded olive green to maroon argillite and limestone of unit uTrNc.*

(uTrNv), and a sedimentary unit (uTrNc) that is found near the base and the top of the flow unit.

uTrNb

Volcanic breccia to agglomerate, at least 100 m thick, is locally developed at the base of the Nikolai formation (Fig. 3). The breccia is characterized by clasts of amygdaloidal basalt within a fine- to medium-grained matrix of the same composition (Fig. 5a). The clasts are subangular to subrounded and range in size from <1 cm up to 40 cm in diameter. It is locally difficult to distinguish between the Nikolai breccias and those of the Station Creek Formation. The main difference is the abundance of amygdules observed within clasts of the Nikolai breccias.

uTrNv

The main component of the Nikolai formation is a thick sequence of flood basalts. At the base of the sequence flows are dark green, vesicular and commonly composed of pillow breccia (Fig. 5b, c). The thickness of the pillowed section is unknown, but must be at least several tens of metres thick based on outcrop distribution. The pillows pass upward into massive basalt to basaltic andesite flows that are characteristically olive green to maroon in colour, highly vesicular and amygdaloidal. Locally, the flows are augite- and more rarely olivine-phyric. Amygdules are filled with chlorite, quartz and epidote. Flows are from one to several metres thick and are discernable by hematite-rich, highly vesicular flow tops and bottoms (Fig. 5d).

uTrNc

Thinly bedded bioclastic limestone and argillite of unit uTrNc are found near the base and near the top of the Nikolai formation. These sedimentary beds are normally less than 50 m thick but in places are nearly 100 m thick. The limestone is dirty grey, fine-grained and thinly interbedded with olive green to maroon, fine-grained argillite (Fig. 5e). This unit is ubiquitous where the Nikolai formation is thick and is laterally continuous over several kilometres (Fig. 2). The limestone has yielded conodonts and macrofossils with late Carnian to early Norian ages (Campbell, 1981; Read and Monger, 1976; Muller, 1967). These fossil constraints indicate an Upper Triassic age for the Nikolai formation.

McCarthy Formation

The McCarthy Formation occurs as a fault bounded exposure at least 100 m thick in the westernmost part of the Quill Creek area (Fig. 2). It consists of interbedded light grey to beige limestone and dark grey argillite and shale that give the outcrops a very distinct striped appearance (Fig. 6a). Individual beds are generally less than 50 cm thick and are often disrupted by extensive faulting and folding. Abundant macrofossils are found throughout this unit. Samples collected during this study have yielded *Monotis subcircularis* (Gabb), a Late Norian bivalve common to the McCarthy Formation outside of the Quill Creek area (Read and Monger, 1976; Mackevett, 1971). Stratigraphic relationships with the underlying Nikolai formation are not well constrained in the Quill Creek area. Elsewhere, the McCarthy Formation conformably overlies the similarly aged Chitistone

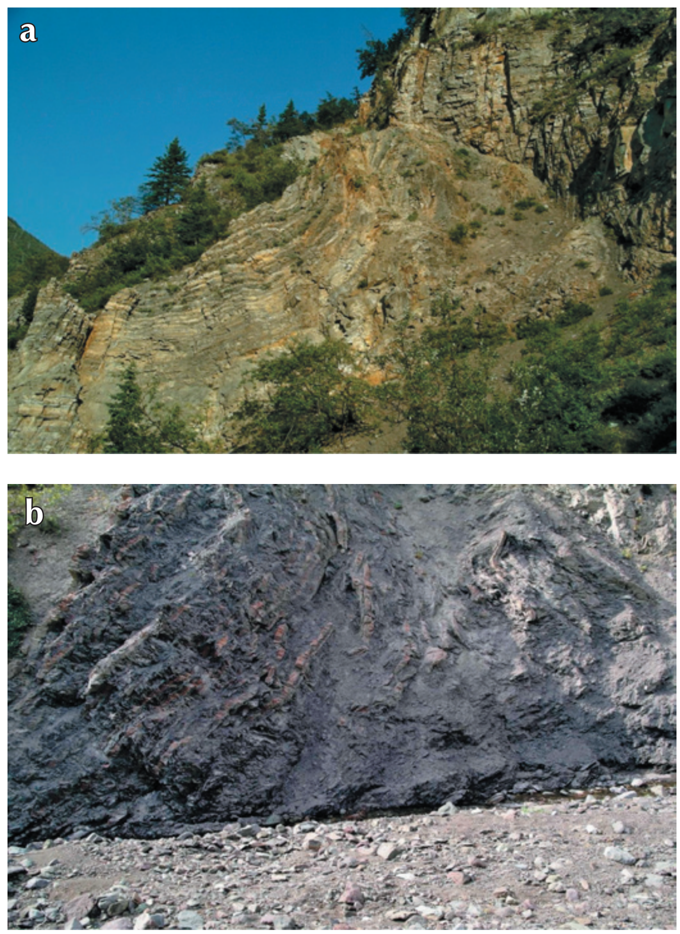


Figure 6. (a) *Distinct striped appearance of interbedded limestone and argillite of the McCarthy Formation;* ***(b)*** *Highly deformed phyllites of the Tatamagouche succession, light bands are red weathering siliceous layers found only in this unit.*

limestone which is in conformable contact with the underlying Nikolai formation (Read and Monger, 1976).

TATAMAGOUCHE SUCCESSION

A sequence of highly deformed phyllite, siltstone, limestone and rare conglomerate that appears to stratigraphically overly the Nikolai formation in one locality and is structurally interleaved with the Nikolai in another, is informally identified here as the Tatamagouche succession (Fig. 2). Outcrops of this succession along Tatamagouche Creek contain distinct, reddish, cherty bands that help to separate the unit from similar rocks within the Hasen Creek Formation (Fig. 6b). Included in the succession is a brick red conglomerate that is exposed in a creek that flows into the Tatamagouche Creek in the western part of the Quill Creek map area. This conglomerate contains pebble- to cobble-sized clasts of grey and green chert, red siltstone, greenish intermediate volcanics and rare granitic rock. Fossils recovered from exposures of the Tatamagouche succession indicate ages for this unit that range from Upper Triassic to Cretaceous (Muller, 1967; Read and Monger, 1976). Relationships with the McCarthy Formation are not known and it may be that the Tatamagouche succession includes the upper part of the McCarthy Formation.

INTRUSIONS

KLUANE MAFIC-ULTRAMAFIC BELT

Layered intrusions of the Kluane mafic-ultramafic belt are found within the rocks of the Wrangellia Terrane

Figure 7. (a) *Typical outcrop of Kluane mafic-ultramafic belt peridotite;* ***(b)*** *Sill of Maple Creek gabbro (uTMg) intruding Hasen Creek Formation;* ***(c)*** *Salt and pepper colour typical of Kluane Ranges suite diorite;* ***(d)*** *Large exposure of Tkope suite quartz-feldspar porphyry (Ofp) intruding Station Creek Formation along Burwash Creek.*

throughout the Kluane Ranges. They are considered to be, in part, the feeders to the Nikolai formation volcanic rocks. Several of these intrusions are found within the Quill Creek map area and include the Quill Creek complex, which hosts the Wellgreen Ni-Cu-PGE deposit (Yukon MINFILE 115G 024, Deklerk and Traynor, 2004). The intrusions occur primarily as sills and dykes near the contact between the Station Creek Formation and the Hasen Creek Formation. They are generally composed of a dunite core surrounded by peridotite and pyroxenite layers, and a pegmatitic to coarse-grained gabbro rim (Fig. 7a; Hulbert, 1997). Many of the sills are ubiquitously altered and locally are almost entirely serpentinized. The thickness of the ultramafic bodies is variable, ranging from several metres to several hundred metres (Hulbert, 1997). No direct, reliable age determinations have been made for the Kluane mafic-ultramafic belt; however, it is believed to be genetically linked to the Maple Creek gabbro that has an associated age of 232±1 Ma (Mortensen and Hulbert, 1991; Hulbert, 1997).

MAPLE CREEK GABBRO

Gabbroic dykes and sills of the Maple Creek gabbro outcrop extensively throughout the Quill Creek area (Fig. 2). These range from small (less than one metre) dykes to larger (over several tens of metres) sills. The Maple Creek gabbros are found almost exclusively within the Skolai Group and only rarely within the lower part of the Nikolai formation (Fig. 7b). They are composed of coarse- to medium-grained, pyroxene gabbro and fine-grained diabase. Where they intrude as sills, the bodies commonly show columnar jointing. They are distinguished from the gabbro of the Kluane mafic-ultramafic belt by their much fresher appearance and lack of pegmatitic phases. The Maple Creek gabbro and the Kluane mafic-ultramafic belt are interpreted as feeders to the Nikolai formation (Hulbert, 1997). U-Pb zircon analyses of the Maple Creek gabbro indicate a crystallization age of 232±1 Ma (Mortensen and Hulbert, 1991).

KLUANE RANGES SUITE

Intrusive bodies of the Kluane Ranges suite extend along the entire length of the Kluane Ranges from the British Columbia/Yukon border to the Alaska/Yukon border in southwest Yukon. One intrusion outcrops along the southwestern margin of the Quill Creek area (Fig. 2) and is composed of salt and pepper coloured, fine- to medium-grained, hornblende-pyroxene diorite to gabbro (Fig. 7c). Outcrops are relatively fresh with little deformation or alteration, with the exception of small epidote veins. Imprecise K-Ar dates for the Kluane Ranges suite in the Quill Creek area indicate a mid-Cretaceous age (117 to 115 Ma; Christopher et al., 1972).

TKOPE SUITE

Outcrops of the Tkope suite are exclusively found along Burwash Creek at the southern extent of the Quill Creek map area (Fig. 2). The suite is a light grey to cream coloured quartz-feldspar porphyry with acicular hornblende and minor biotite phenocrysts (Fig. 7d). The age of the Tkope suite is 28-26 Ma based on K-Ar analyses

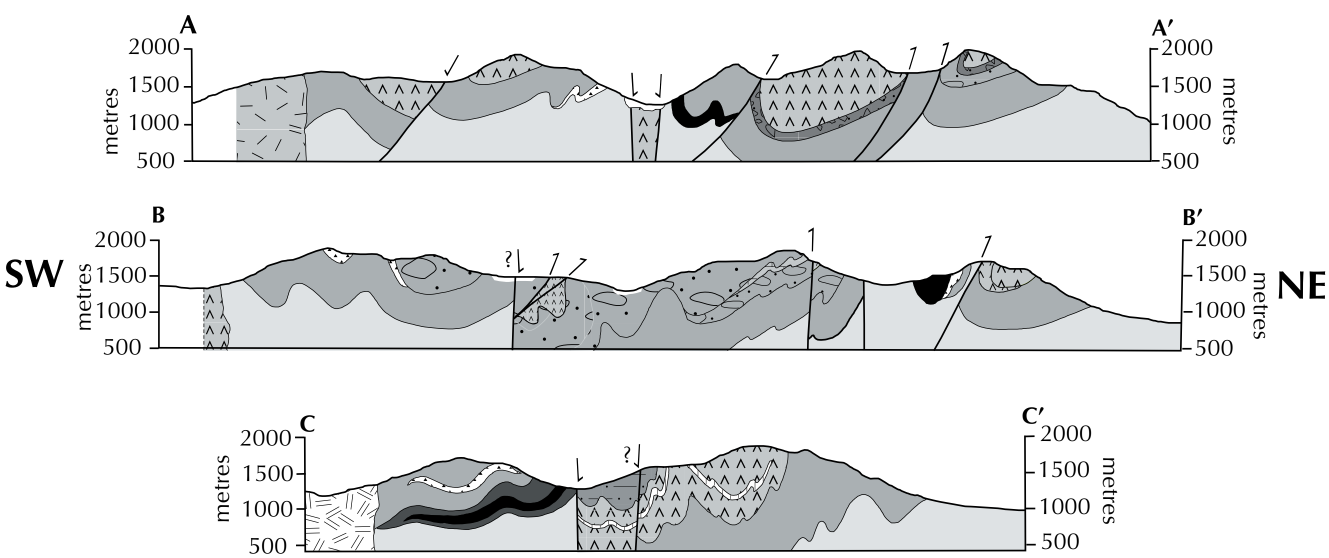


Figure 8. *Schematic cross-sections through the Quill Creek map area. Location of section lines shown on Figure 2. Rock unit fills are the same as Figure 2.*

of biotite from samples collected within and outside of the Quill Creek area (Read and Monger, 1976).

STRUCTURE

The Quill Creek map area is characterized by complex structural relationships that are associated with two major terrane boundaries and reactivation along these boundaries during younger events. The boundaries are now represented by the Duke River Fault and the Denali Fault which bound the map area to the southwest and northeast, respectively, and separate rocks of the Wrangellia Terrane from those of the Alexander Terrane and the Coast Plutonic Complex (Fig. 1).

The oldest and most pervasive structural features evident within the study area are map-scale, northwest trending, and northeast verging overturned folds (Fig. 2). The folds are likely related to northeast-directed contraction that occurred along southwest-dipping faults that are most prominent in the northwest part of the Quill Creek area. These faults apparently place Skolai Group rocks over Nikolai formation locally (Fig. 8). Associated outcrop-scale features indicate that the folds are tight to isoclinal (Fig. 9a, b) and plunge shallowly to moderately to the southwest and southeast. Cleavage formed during folding is generally moderately southwest-dipping but changes to northeast-dipping near Tatamagouche Creek in the southern portion of the map area (Fig. 2, 8).

A second folding event is locally developed within the study area. This second event is best represented by the refolding of the first phase folds that resulted in southwest and southeast plunges of the first phase fold axes.

***Figure 9. (a)** Tight fold in interbedded Hasen Creek Formation limestone and argillite; **(b)** Tight to isoclinal folds in limestone of the Hasen Creek Formation, located near the core of a large regional syncline; **(c)** Elongated clast within strongly deformed volcanic breccia of the Station Creek Formation. Stretching is parallel to pen and occurs along a southwest-dipping structure reactivated during strike-slip faulting; **(d)** North- to northwest-striking, steeply dipping shear zone several metres wide within ultramafic rocks of the Kluane mafic-ultramafic belt.*

Cleavage development related to this folding event suggests that these folds are fairly upright and bedding cleavage relationships indicate that fold axes plunge gently to the south-southwest. It is likely that the second phase of folding is related to deformation along northwest-striking steeply dipping faults. Numerous northwest-striking faults are present at all scales within the Quill Creek area. They are undoubtedly related to the Denali and Duke River faults (Fig. 2). Reactivation of the large southwest-dipping structures responsible for the first contractional event is indicated by shallowly plunging lineations, stretched pebbles and asymmetric crenulations developed within these fault zones (Fig. 9c).

Table 1. *Yukon MINFILE occurrences and associated deposit types found within the Quill Creek area (from Deklerk and Traynor, 2004).*

MINFILE	Name	Deposit type	Status
115G 014	Amp	Porphyry Cu-Mo-Au	anomaly
115G 015	Cork	Porphyry Cu-Mo-Au	drilled prospect
115G 016	Glen	Gabbroid Cu-Ni	drilled prospect
115G 017	Burwash	Besshi massive sulphide	drilled prospect
115G 018	Nelms	Unknown	unknown
115G 019	Jaquot	Gabbroid Cu-Ni	drilled prospect
115G 020	Vug	Unknown	unknown
115G 021	Quill	Gabbroid Cu-Ni	drilled prospect
115G 022	Versluce	Gabbroid Cu-Ni	drilled prospect
115G 023	Callinan	Unknown	unknown
115G 024	Wellgreen	Gabbroid Cu-Ni	underground past producer
115G 025	Airways	Gabbroid Cu-Ni	drilled prospect
115G 026	Musketeer	Besshi massive sulphide	showing
115G 027	Swede Johnson	Gabbroid Cu-Ni	showing
115G 094	Linda	Alaskan Type ultramafic	drilled prospect
115G 095	Arby	Unknown	unknown
115G 102	Tremblay	Cu ± Ag quartz vein	unknown

A number of normal faults are inferred by stratigraphic relationships observed in the Quill Creek map area (Fig. 8). These faults are concealed beneath the Quaternary cover. They are required to explain the position of Nikolai formation rocks, particularly along Nickel and Arch creek valleys (Fig. 2). Campbell (1981) suggested the presence of a graben structure in this area and of normal faults along the Bock's Brook Fault in Tatamagouche Creek.

Several north-northeast- and north-northwest-striking, steeply dipping structures are present throughout the area and appear to offset many of the other structures (Fig. 2, 9d).

Figure 11. *Photograph of area that sample 04-SIS-137-3-1 was taken from. Zone just below hammer in centre of photograph is composed of chalcopyrite, pyrite and malachite.*

MINERALIZATION

Several different mineral occurrences, associated with a variety of deposit types, are found within the Quill Creek map area (Table 1; Fig. 10 [see next page]). The most prevalent are gabbroid Ni-Cu-PGE occurrences associated with the Kluane mafic-ultramafic belt. A detailed investigation of the Kluane mafic-ultramafic belt by Hulbert (1997) identified a number of ultramafic complexes. Of these, the Quill Creek complex, which hosts the Wellgreen deposit (Yukon MINFILE 115G 024), has received the most attention. Drilling by Kluane Joint Ventures in 1988 and 1989 led to an estimate of probable reserves at Wellgreen of approximately 42.3 million tonnes grading 0.36% Ni, 1.42% Cu, 0.51 g/t Pt and 0.34 g/t Pd (Deklerk and Traynor, 2004). Other ultramafic complexes have received little attention recently, but have high potential for similar mineralization. In the Quill Creek map area, the Linda Creek and the Tatamagouche are two

Table 2. *Assay values for selected samples from the Quill Creek area; see Figure 10 for locations. Analysis conducted by ICP-MS at Acme Labs, Vancouver, British Columbia.*

Sample	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	Au ppb	Pt ppb	Pd ppb	Rh ppb
04-SIS-137	1.75	29 470	9	353	43.3	111	136	501	6.59	151.9	49	1.8	45.1	0.1
04-SIS-176	0.74	235	2	78	0.2	92	46	626	7.01	5.4	5	10	24.2	0.23
84-SIS-188	34.15	227	37	187	3.2	282	36	389	10.50	30.9	11	0.9	4.7	0.1
04-SIS-195	0.85	43	2	36	0.0	24	7	1243	4.70	1.5	2	1.2	6.2	0.12
04-SIS-200	1.55	81	3	71	0.2	20	57	267	5.79	1.8	2	< 0.1	2.5	0.06
04-SIS-218	0.7	407	3	125	0.4	20	33	602	7.61	< 0.1	7	4.1	6.3	0.11
04-SIS-232	2.31	120	1	26	0.1	57	28	241	2.40	1.4	4	6.3	11.7	0.14

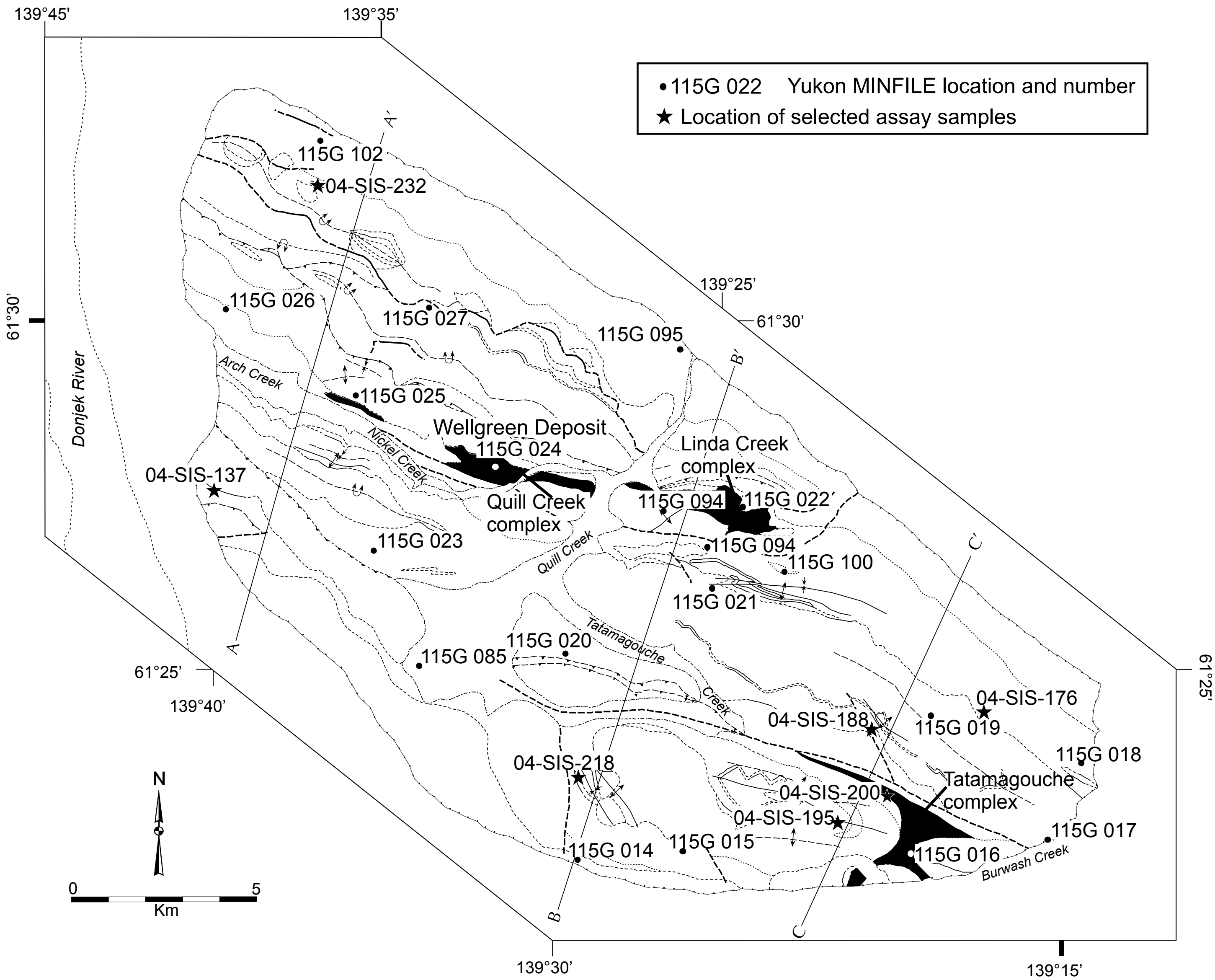


Figure 10. *Location of Yukon MINFILE occurrences (Deklerk and Traynor, 2004) and ultramafic complexes within the Quill Creek map area. Line geology is the same as Figure 2.*

other notable ultramafic complexes (Fig. 10). Of these, the Linda Creek complex has seen the most exploration work, whereas relatively little attention has been given to the Tatamagouche complex. The Tatamagouche complex is considered to be the largest ultramafic complex within the belt and is a highly prospective target for Ni-Cu-PGE mineralization (Hulbert, 1997).

Two porphyry Cu-Mo-Au occurrences, the Amp and Cork, are found within the Quill Creek area (Fig. 11; Yukon MINFILE 115G 014 and 115G 015, Deklerk and Traynor, 2004). The Amp is related to the mid-Cretaceous Kluane Ranges suite and the Cork is associated with feldspar-porphyry of the Tkope suite (Read and Monger, 1976; Deklerk and Traynor, 2004).

The Musketeer and Burwash (Yukon MINFILE 115G 017 and 115G 026) are possible Besshi-type massive sulphide occurrences. Exploration work on the Burwash occurrence included drilling by Nathan Minerals Inc. in 1989 that resulted in assays from drill core up to 1025 ppb Au (Halferdahl, 1991).

Several samples collected during mapping in 2004 were assayed and the results are presented in Table 2. One notable sample (04-SIS-137) returned 2.9% Cu, 43.3 g/t Ag and anomalous Ni and Au values. This sample was taken from the base of the Nikolai formation where chalcopyrite, pyrite and malachite occur within thin quartz veins and altered sediments of the Hasen Creek Formation (Fig. 11).

DISCUSSION

Mapping of the Quill Creek area has identified stratigraphy that is common to the Wrangellia Terrane and reflects several tectonic events. The Skolai Group represents a Late Paleozoic volcanic arc that may be related to subduction of oceanic crust during the amalgamation of the Alexander Terrane and the Wrangellia Terrane to form the Insular Superterrane. Sedimentary rocks of the Slokai Group reflect later basin development during arc subsidence. Upper Triassic oceanic flood basalts of the Nikolai formation represent accumulation of a large amount of igneous material on top of the Paleozoic arc after uplift of the arc, which is indicated by the unconformable upper contact with the Nikolai formation. This was also the time of intrusion of the Kluane mafic-ultramafic belt and the Maple Creek gabbros. Subsidence of the Nikolai plateau led to the formation of the carbonate and sedimentary rocks that overlie the volcanic rocks. Accretion of the Insular superterrane in Middle Jurassic time resulted in the large-scale folding and faulting that is evident within the Quill Creek map area. Late Mesozoic to Cenozoic strike-slip faulting along the entire length of Cordilleran margin overprinted earlier structural features.

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APPENDIX

FOSSIL IDENTIFICATION

Field no.: 04-SIS-138-1 GSC Loc. C-307261

Locality: Yukon Territory

UTM: Zone 7, 571103E, 6814288N

NTS: 115G/05

Loc: 4 km east of Donjek River

Strat: "Carbonaceous Siltstone"

Lith: Interbedded dirty limestone and carbonaceous siltstone

Fossils: *Monotis subcircularis* (Gabb)

Age: Late Triassic, Late Norian