Geology and Mineral Potential of the Usk Map Area (NTS 103I/09), Terrace, British Columbia

JoAnne Nelson, Tony Barresi[1], Ellie Knight[2] and Nicole Boudreau[3]

KEYWORDS: Telkwa Formation, Terrace, Skeena River, Hazelton Group, Kitselas, Stikinia, vein deposits, copper deposits

INTRODUCTION

The Usk map area spans the valley of the Skeena River and its tributaries, over a 530 km^2 area north and east of the town of Terrace, British Columbia (Fig. 1, 2). It includes the lower parts of the Zymoetz (= Copper) River and Kleanza Creek, which flow southwest from their remote headwaters in the Howson Range between Terrace and Telkwa. Chimdemash, St. Croix and Legate creeks drain the Mount O'Brien massif east of the Skeena River. Tributaries west of the river are Carpenter, Sand, Hardscrabble, Shannon, and Lowrie creeks. The topographic names suggest episodes in a long history of settlement. Zymoetz is an ancient name describing the spread of translucent pale blue colour where its waters join the turbid, brown Skeena River. Hardscrabble refers to early placer mining work; Ste.-Croix and Legate were prospectors. Mount O'Brien was named for a young Terrace man killed in World War II.

Within the Usk map area, there are sites and communities that date from roughly 5000 BP to the present day (Berthiaume, 1999). The sites at Kitselas canyon range from ancient encampments to the prosperous village of Gitlaxdzawk, which dominated the Skeena's rocky western bank in historic times. Based on trade and taxation of river traffic, it flourished up to about 1860–1880, when disease and depopulation wiped the settlement out. In the late 1800s, steamboat traffic turned the Skeena River into a major corridor to the interior and a new town, also named Kitselas, was built south of the canyon. The construction of the railroad from 1910 to 1914 refocused communities: the new Kitselas was abandoned and small settlements grew up beside the railroad. Usk was one of these. It is now accessed by a reaction ferry from the highway that was built east of the river in the early 1940s. Terrace itself arose as the railroad and highway developed, and grew with the logging industry. Its northeastern suburb of Thornhill extends into the Usk map area (Fig. 2). A new community, Gitaus, sited on a gravel bench east of the Skeena, has been developed by the Kitselas First Nation over the last 15 years.

[1]*Department of Earth Science, Dalhousie University, Halifax, NS*

[2]*Department of Earth Science, Simon Fraser University, Vancouver, BC*

[3]*Department of Geology, St. Mary's University, Halifax, NS*

This publication is also available, free of charge, as colour digital files in Adobe Acrobat PDF format from the BC Ministry of Energy, Mines and Petroleum Resources internet website at http://www.em.gov.bc.ca/Mining/Geolsurv/Publications/catalog/catfldwk.htm

EXPLORATION HISTORY

The role of mineral exploration in the local economy has waxed and waned through time. The Tshimshian word Kleanza means 'gold', an indication of early placer activity. The opening of the Skeena as a major river route, and the construction of the railway, brought prospectors into the country. Discoveries followed. More than 10 prospects, mainly gold-quartz veins and copper-silver massive sulphide mineralization, eventually saw at least limited production between 1890 and 1942. On a voters list from Kitselas in 1909, 25% of the male population stated their profession as 'miner' (Bennett, 1997, p. 172). In the early 1900s, up to a hundred prospecting parties might be out in a given summer (W. McRae, pers. comm., 2005). Horse trails were built to access workings through tens of miles of arduous mountain valleys and over steep ridges. One such trail joined the headwaters of Chimdemash and Ste.-Croix creeks via 67 switchbacks.

The coming of the Depression and World War II put an end to most of the mining activity. Forest wealth fueled the next economic resurgence. Small mills had been built near the railroad beginning in 1910. During World War I, Sitka spruce from the Skeena River valley was in high demand for airplane construction. Mill development intensified with the opening of the highway during World War II. The Skeena Mill (originally Skeena Forest products) was built in 1960. Between 1950 and 1990, extensive networks of logging roads were constructed into all of the valleys in the area. They offer excellent access to remote locations; however, most of them are presently deactivated and becoming increasingly difficult as routes of travel.

Terrace has a small but active prospecting community. However, compared to well-known mining camps such as Smithers and the Iskut-Stikine region, the area has seen a modest level of modern mineral exploration. In the Usk area, for instance, there are 80 listed mineral occurrences (MINFILE, 2005), but only 25 assessment reports were filed during the period 1980–2004. Most of the work has been done on behalf of individuals and small companies.

In the last three years, there has been a minor resurgence in local mineral exploration. Between 2003 and 2005, Eagle Plains Resources Ltd. has been exploring the bulk tonnage Au and Cu-Mo potential of its large Kalum property north of Terrace (Mihalynuk and Friedman, 2005). The Dardanelle Au-quartz vein mine (MINFILE 103I107) and the Treasure Mountain Cu property (MINFILE 103I090), both of them located immediately south of the Usk map area, were explored and drilled in the summer of 2005. Exploration work continues on a system

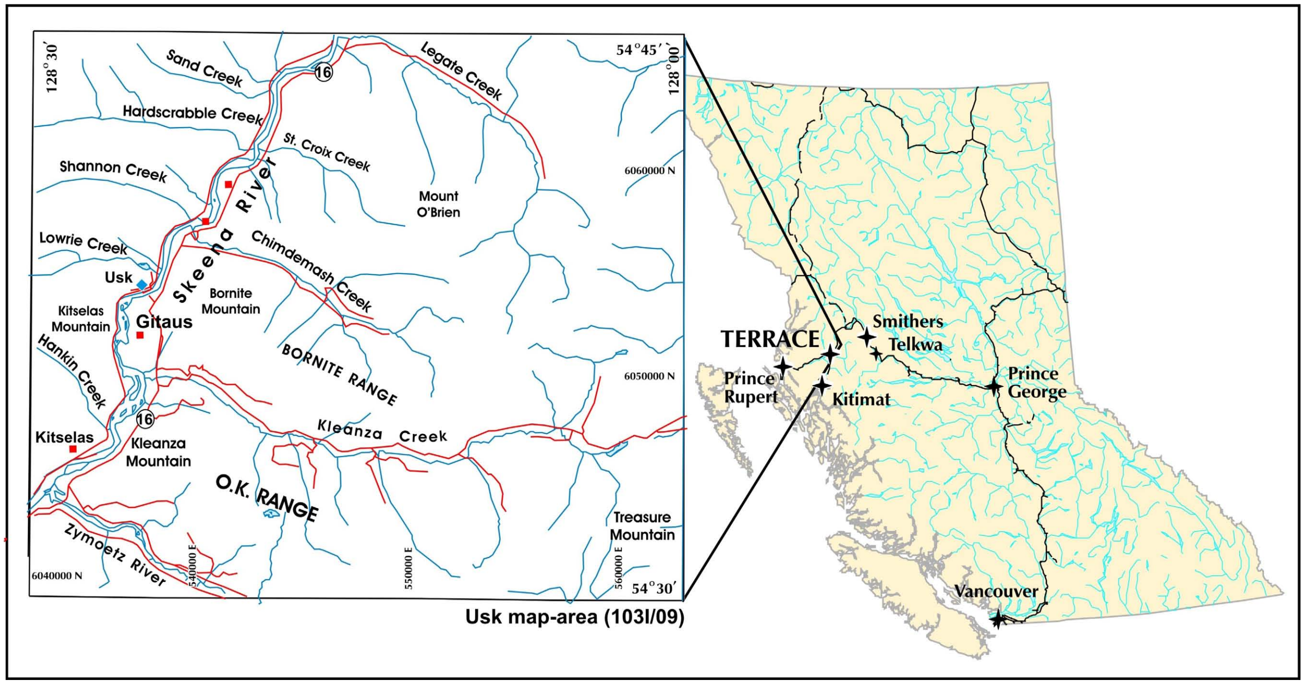

Figure 1. Location and physiography of Terrace, BC, and the Usk map area.

of veins and replacement-style occurrences, the Zona May (MINFILE 103I060) and M&K (MINFILE 103I065) in the upper Legate Creek drainage and Silver Basin in the upper Chimdemash drainage (MINFILE 103I065), by Argonaut Resources (Salat, 2005).

THIS PROJECT

Coastal and northwestern BC are relatively poorly covered by 1:50 000-scale regional geological mapping. At present, roughly 18% of the province has been mapped at 1:50 000 scale. Within NTS 103I, the large-scale sheet that includes Terrace, no 1:50 000-scale mapping is available, except for focused thesis work (Mihalynuk, 1987; Heah, 1991). The Terrace regional mapping project was initiated in 2005, in recognition of this knowledge gap and its potential effect on exploration interest in the area. Results for the Usk map area (NTS 103I/09) will be released as an open file map (Nelson *et al.*, 2006).

In connection with the present study, part of a Ph.D. thesis by Tony Barresi of Dalhousie University will address the volcanic stratigraphy and geochemistry of the Telkwa Formation (Barresi and Nelson, 2006), while an Honours B.Sc. thesis by Nicole Boudreau of St. Mary's University will examine the relationship between the Kitselas volcanic unit and the Hazelton Group.

This project was a cooperative effort between the BC Geological Survey Branch and the Resource Management Department of the Kitselas First Nation (KFN). In the summer of 2005, one BCGS geologist, three geology students and three KFN resource technicians surveyed the Usk map area, using trucks, bicycles and helicopter-supported fly camps. A total of 560 km^2 was mapped, including 160 linear kilometres of roads.

REGIONAL GEOLOGY

Terrace lies within the western extent of Stikinia, one of the intermontane terranes, a large crustal block dominated by the products of episodic Paleozoic through mid-

Figure 2. Looking north along the Skeena River from Thornhill, BC, with Kitselas Mountain on the western skyline and Bornite Mountain and Mount O'Brien on the east.

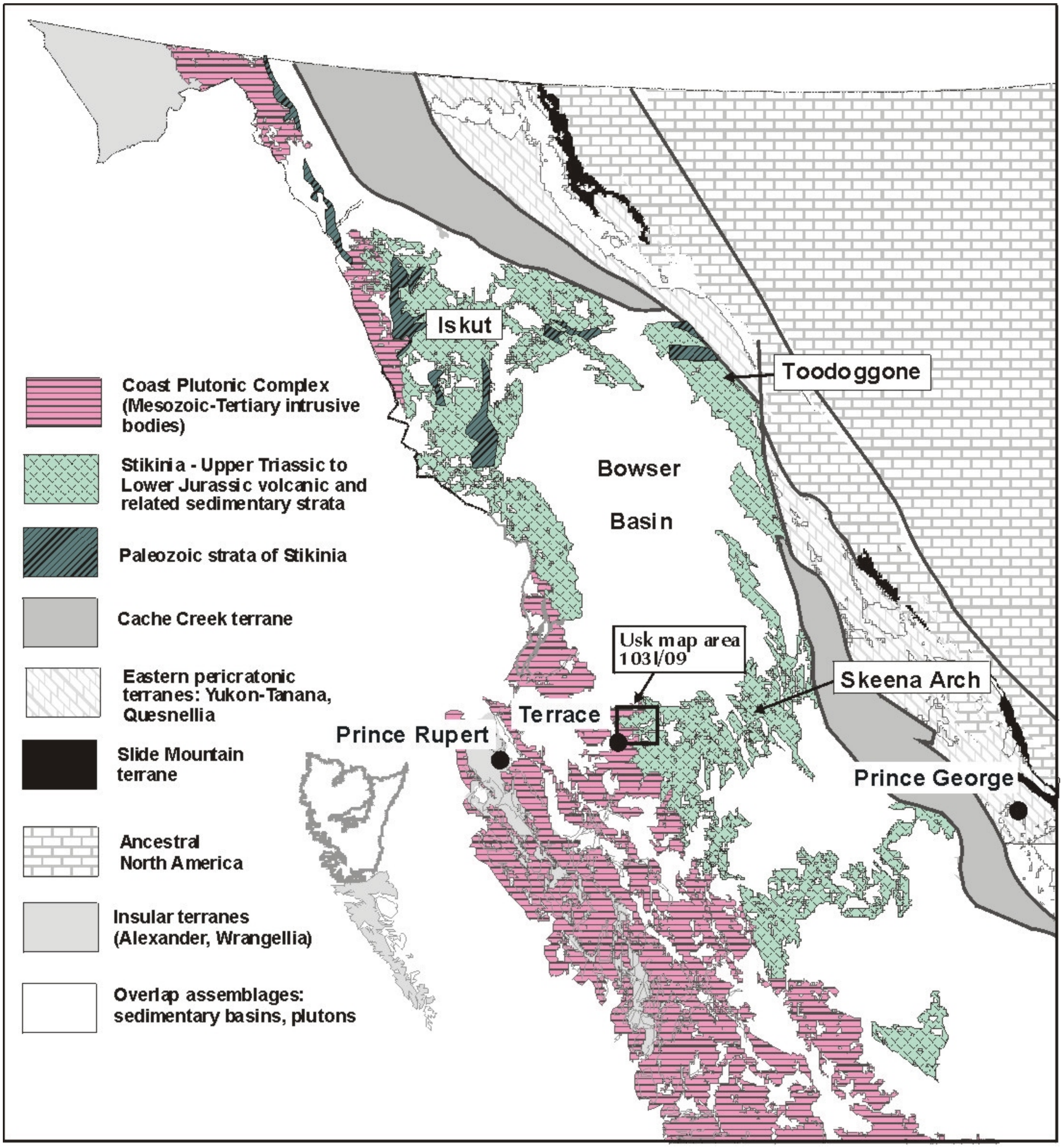

Figure 3. Tectonic setting of Terrace, BC in western Stikinia, on the eastern border of the Coast Plutonic Complex.

Jurassic island-arc magmatic activity (Fig. 3; Monger *et al.*, 1991).

Terrace also lies on the eastern fringe of the Coast Plutonic Complex, a linear belt dominated by granitoid and metamorphic rocks that occupies most of coastal BC. The Coast Plutonic Complex is the deeply eroded and tectonically denuded roots of the mid-Jurassic to Eocene successor arc, which developed along the new western margin of North America following accretion of the intermontane and insular terranes to the continent (van der Heyden, 1992).

Previous 1:250 000-scale mapping (Duffell and Souther, 1964; Woodsworth *et al.*, 1985) shows the general geological features of the Terrace area, which are refined by mapping of the present project (Fig. 4; see Nelson *et al.* [2006] for greater detail).

The oldest recognized stratigraphic unit is a section of upper Paleozoic volcanogenic rocks and limestone, corre-

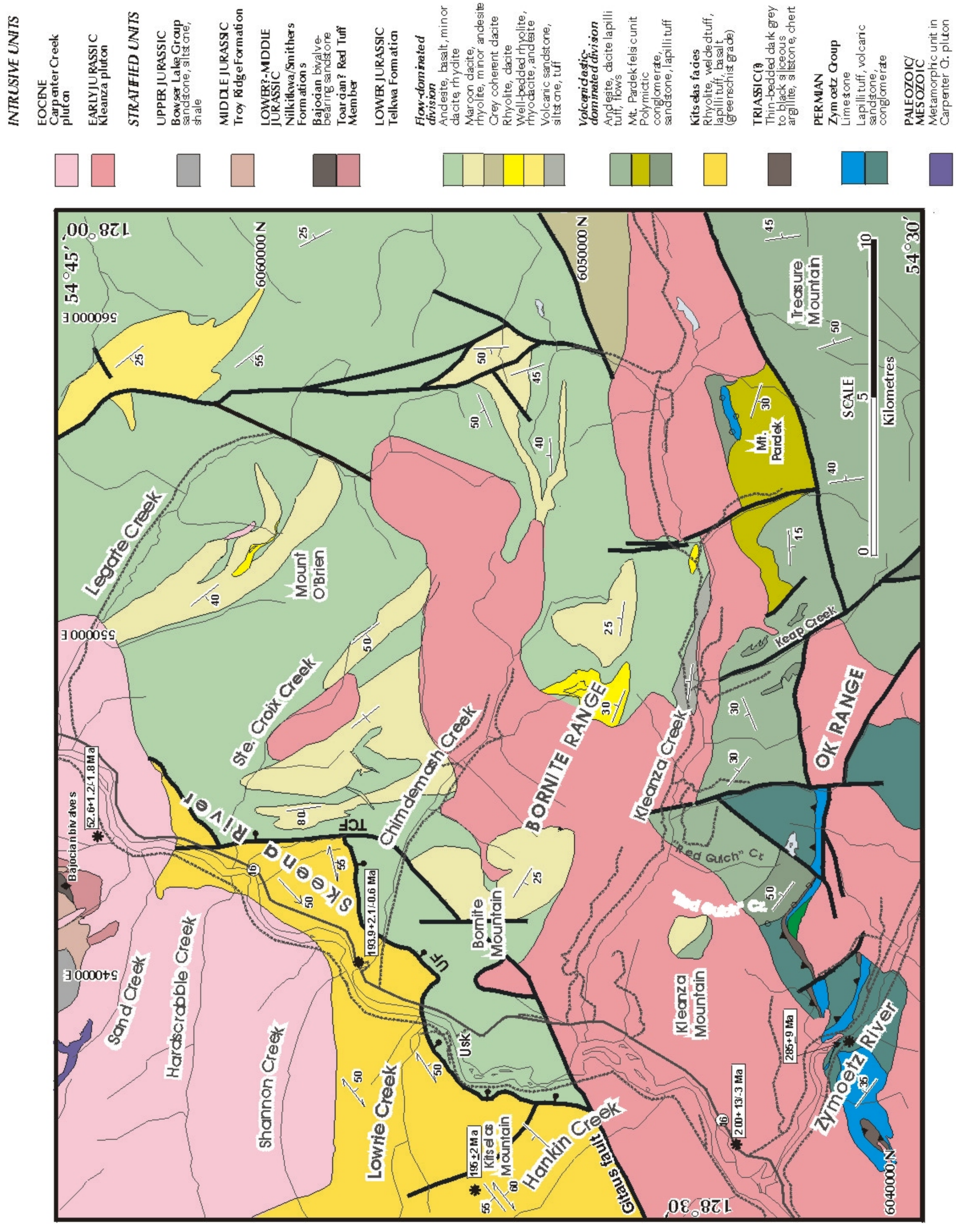

Figure 4. Geology of the Usk map area (NTS 103I/09), near Terrace, BC.

lative with younger strata in the Stikine 'assemblage' in the Iskut-Stikine area (Brown *et al.*, 1996; Logan *et al.*, 2000). It is overlain by Triassic sedimentary strata, which are in turn overlain by the primarily intermediate to felsic volcanogenic rocks that belong to a lower portion of the Hazelton Group, equivalent to the Telkwa Formation in the Smithers area (Tipper and Richards, 1976). North of the Usk map area, Telkwa strata are overlain by the Nilkitkwa, Smithers and Ashman formations and the Bowser Lake Group (Woodsworth *et al.*, 1985, and G. Woodsworth, unpublished mapping, 2006). Small exposures of these rocks occur within the Usk map area near Sand Creek.

Voluminous plutonic rocks occupy much of the drainages of the Zymoetz River and Kleanza Creek. Woodsworth *et al.* (1985) assigned them a Jurassic and/or Cretaceous age. Presently, published and unpublished zircon ages suggest that they are entirely Early Jurassic (*ca.* 200 Ma; Gareau *et al.*, 1997a; G. Woodsworth, pers. comm., 2005). The main body, termed the Kleanza pluton by Gareau *et al.* (1997b), is probably comagmatic with the Telkwa Formation. These rocks contrast with plutons in drainages to the west of the Skeena River, which are Eocene and belong to the Coast Plutonic Complex (Gareau *et al.*, 1997a, b).

A distinctive, mainly felsic volcanic unit underlies the Skeena valley between Gitaus and St. Croix Creek, and extends into the mountains west of the river. It has been named the Kitselas volcanic rocks, from a type locality on Kitselas Mountain (Gareau *et al.*, 1997b). Locally strong foliation and development of greenschist-facies mineral assemblages in this unit led to early interpretations of a Paleozoic age (Duffell and Souther, 1964). Gareau *et al.* (1997a) reported U-Pb zircon ages of *ca.* 194 and 195 Ma from this unit, coeval with the Telkwa Formation regionally (Marsden and Thorkelsen, 1992), and coeval with or slightly younger than the age of the Kleanza pluton locally. G. Woodsworth (unpublished data, 2006; pers. comm; see also Gareau *et al.*, 1997b) proposed that the comparatively high metamorphic grade and structural relationships of the Kitselas volcanic unit to the Telkwa Formation are suggestive of a detachment fault relationship. In this model, the Kitselas volcanic unit would lie in the footwall of an easterly-dipping detachment fault, with the zeolite-grade Telkwa Formation in its hangingwall.

A large, relatively undeformed bulbous pluton of Eocene age (53 Ma; Gareau *et al.*, 1997a) intrudes both the Kitselas volcanic unit and the Telkwa Formation in the northwestern part of the map sheet. Thus, motion on a fault between them must have ceased before this time. On the other hand, a 56 Ma pluton contains fabrics analogous to those in the Kitselas volcanic unit; Gareau *et al.* (1997a, b) considered it to be involved in the detachment-related deformation. Given these constraints, detachment faulting must have taken place in mid-Eocene time, coeval with other recognized crustal shear zones such as the Shames River shear zone west of Terrace (Heah, 1991).

LOCAL GEOLOGY

Detailed mapping of the Usk map area in 2005 (Fig. 4) focused on aspects of the regional geology that remain problematic, particularly those relating to mineral exploration models. The following questions formed the framework for investigation:

- What are the structural and stratigraphic relationships of the Triassic and Jurassic rocks to the underlying Paleozoic section? On one hand, the basal Telkwa Formation has been interpreted locally as Triassic to Jurassic in age (Gareau *et al.*, 1997b); regionally, on the other hand, it is restricted to the Early Jurassic (Tipper and Richards, 1976; Marsden and Thorkelsen, 1992).
- What was the nature and paleogeography of Telkwa volcanism? Prior to this study, the Telkwa Formation remained undivided in the Terrace area, except for one east-west transect south of the Usk map area (Mihalynuk, 1987).
- What are the nature and morphology of the Early Jurassic Kleanza pluton, and what is its relationship to the Telkwa Formation, which it intrudes?
- What are the volcanology and geochemistry the Kitselas volcanic unit, and what was its primary relationship to the Telkwa Formation?
- What is the nature of the structural boundary between the Kitselas volcanic unit and the Telkwa Formation?

Stratified Units

ZYMOETZ GROUP (NEW NAME)

A section of Permian volcanogenic and marine sedimentary strata, including thick limestone, outcrops within and south of the lower Zymoetz River valley (see Duffell and Souther, 1964; Woodsworth *et al.*, 1985). The authors propose that this isolated exposure, located 250 km south of the upper Paleozoic belt of northern Stikinia, be (informally) named the Zymoetz group.

Within the Usk map area, the Zymoetz group outcrops on Copper and Thornhill Mountains, and on the southern slopes of the OK Range (Fig. 4). It is divided into two units, limestone (uPls) and a mixed volcanogenic unit (Pvs) that includes pyroclastic and volcanic-derived sedimentary strata. The volcanogenic unit is highly variable; it includes coarse to fine lapilli and crystal-ash tuffs, well-bedded volcanic sandstone and polymictic volcanic conglomerate. Lapilli tuff ranges from mono to polymictic, and fragments range in size from dominantly sand to dominantly boulders. Clasts are mainly andesitic in composition, with subordinate quartz-phyric dacite and scattered limestone fragments. Plagioclase phenocrysts are ubiquitous; clinopyroxene is common in the andesite. Along the Zymoetz River, unstratified, dark green crystal-ash tuff predominates.

Conglomerate includes clasts derived from the lapilli tuff, as well as limestone and red to white, highly siliceous rocks that may be either rhyolite or chert, neither of which was observed *in situ*. They grade both into lapilli tuff and into volcanic sandstone. Green volcanic sandstone is well bedded and better sorted than the tuff. It interfingers with the limestone. Limy matrix is common, and aids in distinguishing it from Telkwa volcaniclastic units. Macrofossils occur on bedding planes in black shale, and isolated within volcanic sandstone beds.

Limestone in the Zymoetz group shows a strong variability in character. On top of Copper Mountain, outcrops are of pure, white to light grey crystalline marble with local thin colour banding. This unit appears to be nonfossiliferous. On the northern slopes of Copper Mountain and along the road north of the Zymoetz River, thick-bedded grey limestone is interbedded with green volcanic sandstone that grades into crystal-lithic tuff. In both cases, the volcanogenic unit depositionally overlies the limestone. This limestone contains a wealth of macrofossils, including rugose corals, bryozoans and crinoids. Limestone in an isolated exposure southwest of Kleanza Lake is interbedded with laminated, siliceous green tuff and felsic conglomerate. Overall, the intimate relationships of limestone and volcanogenic strata are suggestive of a series of limy banks and small redeposited reefs that developed on an active arc edifice.

The Zymoetz group is dated both by macrofossils and by U-Pb zircon methods. Duffell and Souther (1964) reported extensive coral and brachiopod collections of Permian age, and Gareau *et al.* (1997a) obtained an Early Permian U-Pb age of *ca.* 285 Ma from lapilli tuff on the O.K. Range. These rocks correlate with Permian units in the Iskut-Stikine area (Brown *et al.*, 1996; Logan *et al.*, 2000). The limestone is age equivalent to the Ambition Formation of Gunning *et al.* (1994). One difference is that Zymoetz group limestone interfingers extensively with volcanic-derived clastic deposits, whereas the Ambition Formation contains almost no volcanic material and is interpreted to postdate arc volcanism.

TRIASSIC (?) SEDIMENTARY STRATA

Near the crest of the western O.K. Range, a distinctive unit intervenes between the highest exposure of Permian limestone and the Telkwa basal conglomerate. It consists of less than a hundred metres of thin-bedded, black and grey-laminated radiolarian chert. Bedding in it is roughly conformable with its external contacts, which are covered. This unit is considered to be of Triassic age (Duffell and Souther, 1964; G. Woodsworth, unpublished map, 2006). It resembles Middle Triassic chert in the Iskut-Stikine area (Logan *et al.*, 2000), as well as the Triassic Teh Formation on the BC-Yukon border (Roots *et al.*, in press). Radiolarians collected in this project will be evaluated paleontologically.

A band of thin-bedded black chert occurs in logging cut exposures farther downslope in the Zymoetz River valley, between two panels of Zymoetz group strata (Fig. 4). Bedding attitudes in it are highly variable and generally not parallel to its external contacts. The western contact is interpreted as a thrust fault that repeats Permian and Triassic strata. Similarly, coal black argillite and chert between Copper and Thornhill mountains, which lies structurally below white Permian marble, is interpreted as another Triassic unit in the footwall of a thrust fault.

TELKWA FORMATION (LOWER JURASSIC)

Overview

The Telkwa Formation of the Hazelton Group is the most widespread stratigraphic unit in the Usk map area (Fig. 4). It consists wholly of volcanic and volcanic-derived strata: mostly andesite and dacite but with some basalt and local rhyolitic centres. Stratigraphic relationships in it are complex, due to the irregularity of topography in volcanic environments, abrupt changes in volcanic facies, synvolcanic faulting and the localization of felsic accumulations.

At its base in the western O.K. Range, a polymictic conglomerate unconformably overlies thrust-imbricated Triassic and Paleozoic strata (Fig. 4). The conglomerate interfingers upward with a thick unit of andesitic and lesser dacitic volcaniclastic deposits and minor flows. This unit is divided into the informally named O.K. Range – Treasure Mountain and Kleanza Creek sections by an east-striking fault. The Kleanza Creek section underlies part of the southern slope of the Kleanza Creek valley, overlying (and interfingering with?) a local accumulation of felsic volcaniclastic rocks on Mount Pardek. Andesitic volcaniclastic and sedimentary strata north of Kleanza Creek are overlain by an extensive, flow-dominated unit, the Mount O'Brien section, which comprises andesite, dacite, rhyolite and basalt in decreasing order of abundance. Andesite constitutes about 70% of the unit, dacite 25% and rhyolite 5%. Three distinct rhyolitic centres have been identified in this section.

Conglomerate

Polymictic conglomerate is most abundant at the base of the Telkwa Formation, although lenses of it also occur

Figure 5. a) Polymictic conglomerate near the base of the Telkwa Formation in the western OK Range, containing pink and green siliceous volcanic rocks, chert, limestone, plagioclase and pyroxene-phyric andesite and dacite. b) Detail of pink, crinoidal limestone clast in conglomerate.

stratigraphically higher, interbedded with andesitic lapilli tuff and volcanic sedimentary intervals. It contains both intraformational (andesite, dacite and rhyolite) and extraformational (limestone, black chert, andesite, dacite and rhyolite) clasts (Fig. 5a).

Because both the Zymoetz group and Telkwa Formation are the remnants of mainly intermediate to felsic island arc edifices, distinction between clasts sourced from them must rely on subtle differences of composition and texture. For instance, clinopyroxene and quartz phenocrysts are much more abundant in the Permian volcaniclastic units, whereas well-formed, lath-shaped plagioclase predominates in the basal Telkwa.

Local clast composition of the conglomerate varies considerably. In some areas, limestone clasts are abundant; in others they constitute less than 1% of the population. Fossiliferous clasts contain corals, brachiopods and bryozoans, clearly reflecting their Permian source (Fig. 5b). Near the black Triassic chert band, the base of the conglomerate contains concentrations of black chert clasts.

The basal conglomerate is very coarse and thick bedded. Conglomerate higher in the section is finer grained, and interbedded with sandstone, siltstone and Telkwa lapilli tuff. Rare clasts of limestone in lapilli tuff on the west slope of Treasure Mountain, far upsection from the basal conglomerate, hint at continued (fault-related?) exposure of pre-Jurassic rocks during eruption and deposition of the Telkwa Formation.

O.K. Range – Treasure Mountain Section

From the middle of the O.K. Range east to Treasure Mountain and beyond, a section dominated by maroon and green andesitic volcaniclastic strata dips homoclinally to the east. In addition to andesite lapilli tuff, it comprises about 15% andesite flows, 5% thin intervals of fine-grained volcanic-derived sedimentary beds and 5% dacite lapilli and crystal-ash tuffs. Its basal contact with the conglomerate unit is an interpreted fault; however, rocks in this section are identical to those in the Kleanza Creek section, which demonstrably overlie and interfinger with the conglomerate. The two sections are separated by an east-striking, north-side-down normal fault (Fig. 4).

Andesitic lapilli tuff in the O.K. Range – Treasure Mountain section is thick bedded, ranging from coarse to fine clast dominated, and monomictic to polymictic. Overall, the clasts are mostly plagioclase phyric, with minor local hornblende and clinopyroxene (Fig. 6a).

Textural variations from unit to unit involve percentage and size of phenocrysts, which are typically lath shaped, euhedral and 2–5 mm long. Some tuff units contain crowded porphyritic and fine grained, holocrystalline clasts that tend to be strongly epidotized (Fig. 6b). The authors interpret these as hypabyssal clasts altered in place, prior to incorporation in an explosive eruptive unit. Similar alteration patches were observed in the Kleanza pluton in the Bornite Range.

Andesite flows are coherent, tabular to lensoid units 20–200 m thick, that in places grade through brecciated into lapilli tuff. Volcanic textures are identical to those in the tuff. These flows are only locally amygdaloidal, in contrast to flows in the Mount O'Brien section.

Thin units of bedded volcanic sandstone, siltstone and mudstone represent quiescent intervals. Subaqueous deposition is indicated by graded bedding and mudstone rip-up clasts.

Dacitic units are maroon, brick red, light grey, lavender and pink. They comprise lapilli and crystal-ash tuffs and minor coherent dacite. Clasts and coherent portions are very siliceous and aphanitic to glassy, and may contain sparse, very small (<1 mm) feldspar phenocrysts. West of Treasure Mountain, three thin dacitic units occur in association with thin-bedded volcanic sedimentary strata. One of them exhibits a polymictic base, involving andesite clasts from underlying units, and a monomictic top. Degree of welding increases upward within the unit.

Kleanza Creek Section and Mount Pardek

This section extends along the southern slopes of the Kleanza Creek valley, from Kleanza Mountain to Mount Pardek; its sedimentary upper part is exposed near the main logging road north of Kleanza Creek (Fig. 4). In the west, its base consists primarily of andesitic lapilli tuff that transitionally overlies and interfingers with polymictic conglomerate. To the east, the basal unit is the felsic tuff sequence exposed on Mount Pardek, which overlies Permian

Figure 6. a) Coarse-grained Telkwa Formation lapilli tuff from near Treasure Mountain, showing plagioclase-hornblende-phyric clasts with well-formed phenocrysts. b) Epidote-altered clasts in lapilli tuff.

limestone and conglomerate. This, in turn, is overlain by andesitic lapilli tuff and derived sedimentary layers. The authors interpret the Mount Pardek sequence as the products of a nearby felsic centre.

The Mount Pardek sequence consists of thin, quartz-feldspar-phyric flows, water-laid tuff units and resedimented volcaniclastic deposits (Fig. 7).

Although dominantly felsic, it also contains andesitic volcaniclastic layers. Felsic units are typically light pastel green. Unlike other felsic units in the Telkwa Formation, they contain up to 60% clear, euhedral quartz crystals. Evidence of subaqueous deposition includes grading and crude sorting in well-bedded units. They are probably of turbiditic origin. Overall, the sequence is up to 1200 m thick. The dominantly felsic unit grades upward into andesitic lapilli tuff, sandstone and siltstone that are identical to those of the O.K. Range – Treasure Mountain section.

Figure 7. Thick-bedded felsic lapilli tuff, Mount Pardek, looking north across Kleanza Creek to the main logging road.

West of Kipulta Creek, a lower felsic sequence consists of thin-bedded, colour-banded rhyolite tuff and waxy, translucent rhyolite. Lapilli tuff ranges from monomictic to polymictic, with green to pink rhyolite and also quartz-vein clasts. This sequence, like that on Mount Pardek, is overlain by volcaniclastic beds of intermediate composition, including lapilli tuff and maroon, well-bedded sandstone and siltstone.

Between Keap Creek and ‘Red Gulch’ Creek, andesite lapilli tuff with thin intervals of volcanic sandstone and siltstone overlies and interfingers with the basal Telkwa conglomerate. Polymictic conglomerate with limestone clasts occurs high in the section, particularly on the slopes west of Keap Creek. The conglomerate thickens southward, consistent with a topographic high south of the main Telkwa accumulation.

The northeast-facing sedimentary sequence north of Kleanza Creek is separated from the coarser lapilli tuff by an apophysis of the Kleanza pluton, although it is identical in lithology and bedding attitude to the volcanic-derived sedimentary intervals farther south. It is overlain by andesite flows and coarse lapilli tuff of the Mount O’Brien section along a transitional contact.

Mount O’Brien Section

This widespread unit extends from Kleanza Creek through the eastern and northern boundaries of the map area, including Bornite Mountain, Mount O’Brien and the ridges northeast of Legate Creek (Fig. 8a).

It is dominated by andesite and dacite flow/lapilli tuff eruptive units that alternate on scales of tens to hundreds of metres. The larger dacite bodies are shown on Figure 4. Rhyolite is also present in three separate centres, and aphyric basalt accompanies the andesite in places. In the western part of the section, beds are very thick and alternation between andesite/basalt, dacite and rhyolite occurs over hundreds of metres. East of Legate Creek and in the Treasure Creek area, the section is well bedded, individual flow units are thinner, and alternation between andesite and lesser dacite occurs at a scale too small to depict in regional mapping. These rocks are grouped with the andesite.

Andesite in this section is texturally (and compositionally?) different from that in the volcaniclastic-dominated sections to the south. Plagioclase is tabular rather than lath-shaped, and less euhedral. Synneusis (clumping of individual crystals due to weak attraction on flat faces) gives them a raggedly terminated appearance. Average plagioclase size varies from unit to unit, ranging from a few millimetres to, locally over a centimetre in length. Subsidiary clinopyroxene occurs in some of the flows. Mount O’Brien andesite flows tend to be amygdaloidal, from abundant tiny pinpricks to irregular, zeolite±quartz±epidote±chlorite±pumpellyite-filled cavities many centimetres across (Fig. 8b).

Dacite units are composite, consisting of coherent flows and flow breccias, lapilli tuff, welded to nonwelded tuff with lithic and pumice fragments, and less common crystal tuff (Fig. 8c). Texturally, they resemble the much less extensive dacite south of Kleanza Creek. Colours range from maroon to brick red to pastel shades of lavender, pink, cream and orange. All of these rocks are markedly more siliceous than the andesite. They are aphyric to finely porphyritic, with a small percentage of tiny, submillimetre plagioclase phenocrysts.

Three significant accumulations of rhyolitic volcanic rock occur within the Mount O’Brien section: they are located in the middle of the Bornite Range southwest of the headwaters of Chimdemash Creek, north of Mount O’Brien, on the northernmost ridge and cirques between St. Croix and Legate Creeks; and in the northeastern portion of the map area northwest of the headwaters of Legate Creek. These units are typically closely associated with minor amounts of dacite, basalt and andesite, but have been mapped at 1:50 000 scale wholly as rhyolite. Pyroclastic rocks within these units include nonwelded to strongly welded lapilli tuff with lithic and pumice fragments; coherent rhyolite (Fig. 8b,c) occurring as thin flows, minor domes and cryptodomes that commonly grade into flow breccia; beds of resedimented felsic debris ranging from conglomerate to sandstone; and local thin-bedded, aphanitic, highly siliceous units, which may represent felsic ash tuff or exhalitive chert.

Individual beds range in thickness from less than 1 m to more than 30 m and are normally laterally continuous with little change in volcanic or sedimentary facies. Coherent rhyolite and rhyolite fragments in volcaniclastic deposits are typically highly siliceous, flow banded, aphanitic, semitranslucent and white, pink, orange, lavender or brick red in colour. In these three locations, the high concentration of rhyolitic rocks, especially coherent rhyolite, leads to the interpretation that each location is proximal to a localized centre of felsic volcanism. These units lack the light green pastel colour, abundance of quartz phenocrysts and turbiditic sedimentary structures that characterize the Mount Pardek felsic unit located to the south.

Regional Variations in the Telkwa Formation

A dramatic regional change in the stratigraphy occurs between the O.K. Range – Treasure Mountain and Kleanza Creek sections located in the southern portion of the map area and the Mount O'Brien section in the north. The Mount O'Brien section is dominated by volcanic flows of intermediate composition, and local felsic accumulations that are proximal to eruptive centres; the O.K. Range – Treasure Mountain and Kleanza Creek sections are dominated by volcaniclastic deposits. It is clear that the southern sections represent a more distal volcanic facies than the coherent flows of the northern section (Barresi and Nelson, 2006). The authors propose that the southern sections are a thick accumulation of volcaniclastic material originating from volcanic centres in the Mount O'Brien section. This material was deposited in a subsiding basin south of Kleanza Creek. East-trending faults in the southern sections, particularly the fault separating the O.K. Range – Treasure Mountain section from the Kleanza Creek section, may be original basin-bounding faults. The differences in volcanic facies between the southern and northern sections are not due to a juxtaposition of different positions in a continuous stratigraphic sequence; rather, they represent a geographic change in facies (Barresi and Nelson, 2006).

Kitselas Facies (Lower Jurassic)

The Kitselas facies of the Telkwa Formation is well exposed in a homoclinal, northwest-facing sequence on Kitselas Mountain and the ridge between Shannon and Lowrie creeks. It also outcrops east of the Skeena River between Usk and the ridge north of St. Croix Creek. On Kitselas Mountain, cleavage development is spaced and original textures are very well preserved. The section is predominantly felsic, with >95% dacite or rhyolite along with a minor mafic component of basalt, andesite(?) and diabase. The base of the exposed section, which outcrops on the east side of the Skeena River and at the base of Kitselas Mountain, is primarily coherent rhyolite. The majority of the rocks higher in the section, which form Kitselas Mountain, are thick-bedded volcaniclastic units (Fig. 10a).

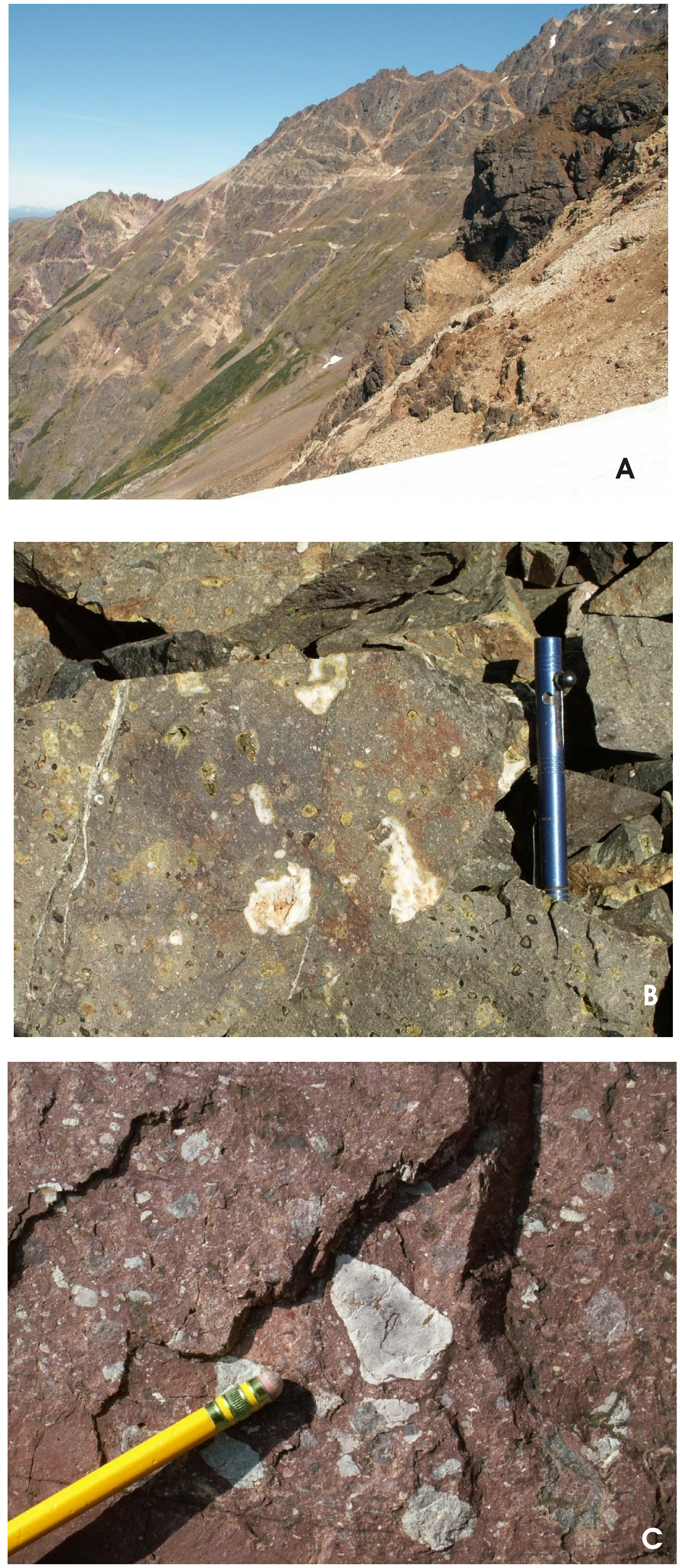

Figure 8. a) South face of Mount O'Brien, showing very thick, maroon andesite flows cut by a gently dipping diorite dike swarm related to the Kleanza pluton. b) Andesite with large, irregular amygdules from the Mount O'Brien section. c) Bright red dacite lapilli tuff with pale siliceous clasts.

The coherent rhyolite is typically medium grey to light purple and aphanitic with rare feldspar microphenocrysts. Flows, which are transitional into flow breccia, have similar characteristics to the larger coherent bodies but are colour and flow banded on a millimetre to centimetre scale. The volcaniclastic portion of the section includes rhyolitic to dacitic lapilli tuffs, welded tuff (Fig. 10b) and rare beds of crystal and/or ash tuffs and resedimented volcanic rocks. Lapilli and welded lapilli tuffs are monolithic, with dominantly sand to pebble-size lapilli. The dominant lapilli compositions are homogeneous aphanitic white, medium purple or grey rhyolite and pumice; minor plagioclase-phyric lapilli and scoriaceous bombs are locally present. Welded tuff exhibits both normal and normal-reverse grading, and the typical aspect ratio of pumice clasts is 1:5. One thin bed of resedimented volcanic rock grades upward from a laminated mudstone base to a conglomerate. Sedimentary structures within this section include flame structures, load casts and crossbeds, which together are suggestive of a subaqueous depositional environment.

Figure 9. Flow-banded rhyolite on the Bornite Range.

Basalt on Kitselas Mountain occurs as three continuous but thin (60–220 m) units. The thickest of these units caps the summit of Kitselas Mountain, and the other two outcrop on its western ridge. They are various shades of blue-grey and are defined by aphanitic, hackly and vesicular to scoriaceous textures. Several zones within the basalt on the Kitselas summit have been thoroughly epidotized, leaving them a brilliant pistachio green colour. These zones are texturally distinguishable from the unaltered basalt, as they have smaller and rarer amygdules and are holocrystalline as opposed to aphanitic. These zones are interpreted to represent proximity to eruptive fissures or centres where hydrothermal alteration would be concentrated. Other mafic rocks within the Kiteselas volcanic unit include minor diabase dikes on the southeast slope of Kitselas Mountain and thin concordant flows or sills exposed on the slopes east of the Skeena River.

Comparison of Kitselas Facies and Felsic Centres Elsewhere in the Telkwa Formation

The Kitselas facies is coeval with the Telkwa Formation (Gareau *et al.*, 1997a); however, its stratigraphic relationship to the Telkwa, locally or regionally, is uncertain. A brief comparison of the physical features of the Kitselas felsic rocks to felsic centres located within the Telkwa Formation in the Usk map sheet is presented here; a more detailed examination, including petrographic and geochemical comparisons is the subject of a B.Sc. thesis currently in progress by Nicole Boudreau.

The Kitselas volcanic rocks are dominantly rhyolitic in composition and consist of a thick section of coherent rhyolite at the base of the exposed section, overlain by an equally thick section of volcaniclastic rocks exposed on Kitselas Mountain. There is no analogue within the Usk map sheet for the thick coherent rhyolite body at the base of the section. However, the exposures of Telkwa felsic centres may be on the flanks of larger, unexposed rhyolite bodies, as is suggested by the thick accumulations of volcaniclastic material in these locations. The upper volcaniclastic section of the Kitselas volcanic rocks is very similar to Telkwa felsic rocks. Both are characterized by similar facies, textures and rock types, and are bedded on a similar scale. The most obvious differences between these rocks are that the Telkwa felsic rocks occur in a wide variety of colours and often have multiple rock types within individual tuff beds, whereas the Kitselas rocks are uniformly white to grey (or rarely purple) and are normally (apparently) monolithic.

Nevertheless, because the Kitselas rocks exhibit higher degrees of metamorphism and alteration, these features found in the Telkwa felsic rocks may simply be obscured in the Kitselas. Although there is no exact analogue for the Kitselas volcanic rocks within the Telkwa in the Usk map area, the physical features of the Kitselas volcanic rocks are consistent with those of the Telkwa.

NILKITKWA AND SMITHERS FORMATIONS

Along logging roads north of Sand Creek, inliers within the Carpenter Lake pluton consist of three units: bright maroon, thin-bedded felsic tuff and basalt; thin-bedded, siliceous and tuffaceous siltstone; and brown sandstone with large bivalve fossils. These units resemble, respectively, the ‘Red Tuff’ member of the Nilkitkwa Formation (Tipper and Richards, 1976); the so-called ‘pyjama beds’, correlative with the mid-Jurassic (Toarcian and Bajocian) Troy Ridge and Yuen formations (Tipper and Richards, 1976; Anderson, 1989); and the Smithers Formation (Tipper and Richards, 1976) and Toarcian to Bajocian sandstone intervals within the Eskay belt (Alldrick *et al.*, 2005).

The maroon felsic tuff-basalt unit is distinguished from Telkwa volcanic facies because of the uniformly thin-bedded, fine-grained character of the tuff, interbedded with thin, aphyric, amygdaloidal basalt flows. Accretionary lapilli were noted at one outcrop. The siliceous siltstone unit displays the dark and light colour banding typical of the ‘pyjama beds’, a lithotype also recognized within the Eskay belt (Alldrick *et al.*, 2005). The brown sandstone, with its lack of obvious chert detritus and abundance of large bivalves, more closely resembles mid-Jurassic clastic units than it does the Bowser Lake Group. A collection of the bivalves was submitted to T. Poulton of the Geological Survey of Canada for identification. His report (Table 1) indicates a probable early Bajocian age, equivalent to the older part of the Smithers Formation.

In the area north of Sand Creek, G. Woodsworth *et al.* (unpublished mapping, 2006) showed Bowser Lake Group strata overlying the Nilkitkwa and Smithers units described above. These exposures were not visited in 2005.

METAMORPHIC UNIT IN SAND CREEK HEADWATERS

An enclave of metamorphic rocks lies within the Carpenter Lake pluton in the northeastern corner of the map area. They consist of brown, black and grey, variably pyritic hornfels with local limy pods. Microscopically, they contain grains of plagioclase, quartz and minor K-feldspar, along with metamorphic biotite, actinolite and diopside. Their protolith was probably thin-bedded tuffaceous wacke and dirty pelite. A strong, pre-contact metamorphic foliation is present. In character, the unit resembles impure clastic rocks of the Smithers Formation or Paleozoic volcaniclastic rocks of the Zymoetz group, but the exposure was too small to provide definitive information.

Intrusive Units

KLEANZA PLUTON (EARLY JURASSIC)

The Kleanza pluton is a large, sprawling, heterogeneous body with apophyses along the Zymoetz River, Kleanza Creek and southeast of Mount O'Brien (Fig. 4). It has been dated as Early Jurassic (*ca.* 200 Ma U-Pb date on zircon; Gareau *et al.*, 1997a). As is typical of intermontane plutons of this age (*cf.* Woodsworth *et al.*, 1991), it varies texturally from fine grained to porphyritic to coarse grained equigranular, and compositionally from gabbro to granite. Its marginal phases tend to be more mafic than those in its interior, and more variable. On Copper Mountain, for instance, microdiorite (a fine-grained, salt and pepper rock composed of 60% plagioclase and 40% pyroxene) alternates on a 10 m scale with porphyritic intrusive andesite, gabbro and very coarse grained hornblende pegmatite bodies. Microdiorite is common within the southwestern part of the pluton. Because of its fine-grained nature, it can be difficult to distinguish from similarly textured extrusive units. Key diagnostic features are the absence of phenocrysts, amygdules and fragmental textures.

South of Mount O'Brien, fine-grained border phases of the Kleanza pluton include pink plagioclase-phyric monzonite and green andesite that is texturally identical to nearby flows, except for its lack of amygdules and unstratified character. This part of the pluton is possibly a feeder to Telkwa extrusive units.

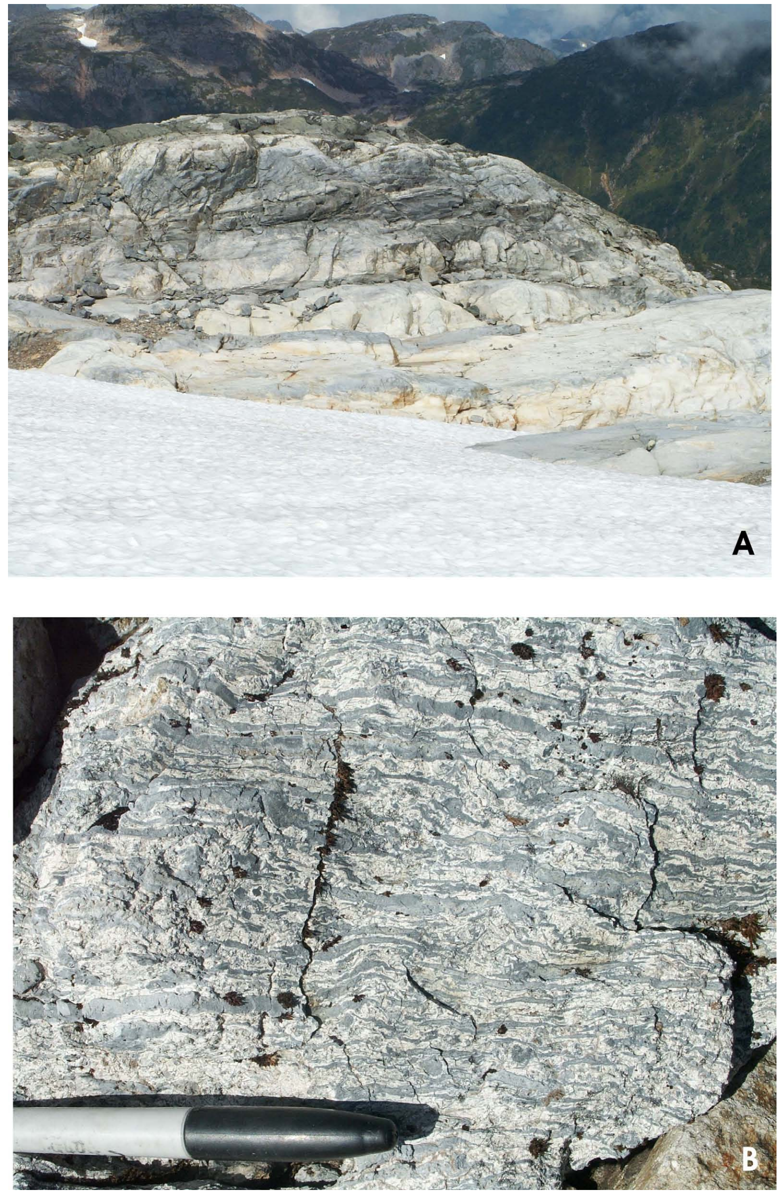

Figure 10. a) Part of the extensive, thick-bedded rhyolite to dacite volcaniclastic unit of the Kitselas member; looking west from near Kitselas Mountain. b) Welded tuff, Kitselas member.

Much of the interior of the Kleanza pluton consists of coarse-grained, equigranular hornblende-biotite granodiorite, with lesser diorite and granite.

The Kleanza pluton intrudes strata of the Zymoetz group, as well as the Telkwa Formation. Contacts both parallel and crosscut the stratigraphy. In the valley of Kleanza Creek, the pluton occurs at low elevations, flanked by Telkwa Formation on adjacent high ridges (Fig. 4; see also Barresi and Nelson, 2006). This configuration suggests a roof contact. Contacts in the Chimdemash Creek valley are steeper and more crosscutting. Overall, the pluton seems to have formed as a branching and possibly stacked set of laccolithic arms that delaminated and domed the stratigraphic section. It was probably emplaced at shallow depths. Contact metamorphism around its margins is only well developed in the Zymoetz group on Copper Mountain, where diopside-garnet assemblages occur in limestone. Farther

TABLE 1. REPORT ON MACROFOSSILS FROM SANDSTONE NEAR SAND CREEK.

Report No. J6-2005-TPP

Report on one collection of Jurassic bivalves collected by JoAnne Nelson, BC Geological Survey, in Terrace area, BC (NTS 103I/09), 2005

GSC Locality C-500768: Field no. 05NB5-6; UTM Zone 9V, 543161E, 6067163N

Identifications:

Plagiostoma sp. cf. *hazeltonense* McLearn
Ctenostreon(?) sp.
Lopha(?) sp.
other bivalves, indeterminate
belemnites, indeterminate
terebratulid brachiopod, indeterminate

Age: Early Bajocian probably

The fossils are very poorly preserved fragments and imprints. This fauna is represented best in British Columbia at Hudson Bay Mountain near Smithers and in central Whitesail Lake map area. It occurs in Early Bajocian beds of the Smithers Formation, together with the ammonite *Sonninia.* Other Middle Toarcian through Bathonian ages for these fossils are remotely possible, but very unlikely in the Terrace area.

T.P. Poulton
October 4, 2005

north, zeolite-facies assemblages persist to within metres of its margins.

CARPENTER LAKE PLUTON (EOCENE)

The Carpenter Lake pluton underlies a large area in the drainages of Carpenter, Sand and Hardscrabble creeks, as well as the lower reaches of Legate Creek. It has been dated as Eocene by a 53 Ma U-Pb date on zircon (Gareau *et al.*, 1997a), which is consistent with other plutons belonging to the Coast Plutonic Complex. It comprises large areas of homogeneous granodiorite, tonalite and granite, as well as areas of abundant dikes of variable compositions and textures. Among these, pink orthoclase-phyric granite, medium-grained granodiorite and diorite, and green andesite are most common. Pink pegmatite and aplite occur in parts of it, notably in the headwaters of Sand Creek.

STRUCTURE

The most important structure in the area is the Usk fault (UF), which abruptly separates footwall felsic rocks of the Kitselas volcanic unit from hangingwall Telkwa Formation andesite intruded by the Kleanza pluton (Fig. 4). It is an undulating surface that dips variably to the southeast, offset by the steep, east-side-down Gitaus and Tumbling Creek faults. The UF corresponds to an abrupt change in bedding attitudes. In its footwall, well-bedded Kitselas units strike uniformly southwest and dip and face northwest, away from the fault. In its hangingwall, Telkwa units strike southeast and dip moderately to steeply southwest, toward the fault. The UF is located within a metamorphic transition zone between greenschist and zeolite facies. Greenschist-facies assemblages are developed both within mafic rocks of the Kitselas volcanic unit and within the lower part of the Telkwa Formation, up to 300 m above the UF. Spaced, southeasterly-dipping zones of strong penetrative cleavage occur throughout the Kitselas volcanic unit. Strongly foliated zones are particularly well developed near its structural top (*e.g.*, in highway outcrops north of Chimdemash Creek). The broader shear zone persists hundreds of metres above the UF, expressed as strongly cleaved intervals and chloritic brittle shears within the Telkwa Formation and the Kleanza pluton.

Overall, the UF appears to be a discrete detachment fault corresponding to an abrupt lithological break, located within a broader zone of shearing and strong fabric development, the Usk shear zone. Attenuation occurred across the entire zone, with displacement focused on the UF. The original relationship of the Kitselas volcanic unit to the Paleozoic to Jurassic rocks in the hangingwall of the UF is still not known.

MINERALIZATION

The Usk map area contains about 80 documented mineral occurrences of several deposit types (Fig. 11; see also Kindle [1937a, b] for detailed descriptions of historic showings). Copper mineralization is common and widespread, and includes quartz vein, quartz-poor sulphide vein (bornite-chalcocite-epidote-specular hematite), shear-hosted, disseminated and replacement styles, in addition to the nearly ubiquitous malachite stains of uncertain origin. Silver is commonly associated with Cu minerals, particularly in veins and shears. Gold favours quartz veins, and occurs either with pyrite alone, as at Columario (MINFILE 103I077), or in polymetallic veins with chalcopyrite, bornite, sphalerite, galena, tetrahedrite and other sulphosalts. Molybdenite occurs within and near the Carpenter Lake pluton.

The origin and associations of the Cu and Au-bearing epigenetic mineralization are unclear, because the evidence is circumstantial. Four possibilities exist, listed in order of implied age of mineralization:

1) Copper-rich shear zone – hosted and replacement occurrences in the Telkwa Formation, notably on the north-south Treasure Mountain trend (Fig. 11) could be related to early fluid migration associated with Hazelton-age volcanic activity.

2) Hydrothermal systems associated with the Kleanza pluton could give rise to a broad spectrum of epigenetic occurrences, such as veins, shear-hosted, disseminated and replacement massive sulphide minerals.

3) The Early Tertiary Usk shear zone and Usk detachment fault could be implicated in the formation of local epigenetic mineralization.

4) Veins could relate to hydrothermal effects of the Eocene Carpenter Lake pluton.

The spatial distribution of Au and Cu-rich occurrences on Figure 11 points most strongly at the Kleanza pluton as a key factor in their formation. Most of the Au-rich veins concentrate in a band that corresponds to the northeast-trending northern lobe of the pluton, which extends from the mouth of the Zymoetz River to the headwaters of Legate Creek. This includes the cluster of veins on Kleanza Mountain, and the Silver Basin (MINFILE 103I067) to Zona May – Frisco area (MINFILE 103I063, 061).

The Kleanza pluton is a heterogeneous multiphase body. Outcrop patterns outline a curviplanar shallow top to both lobes. It was probably intruded as a sprawling, laccolith-shaped body to high crustal levels in zeolite-facies country rocks. The upper levels of the pluton and its volcanic cupola are extensively exposed in the area, constituting a highly favourable environment for mineralization. Major ankeritic alteration occurs in the Silver Basin area,

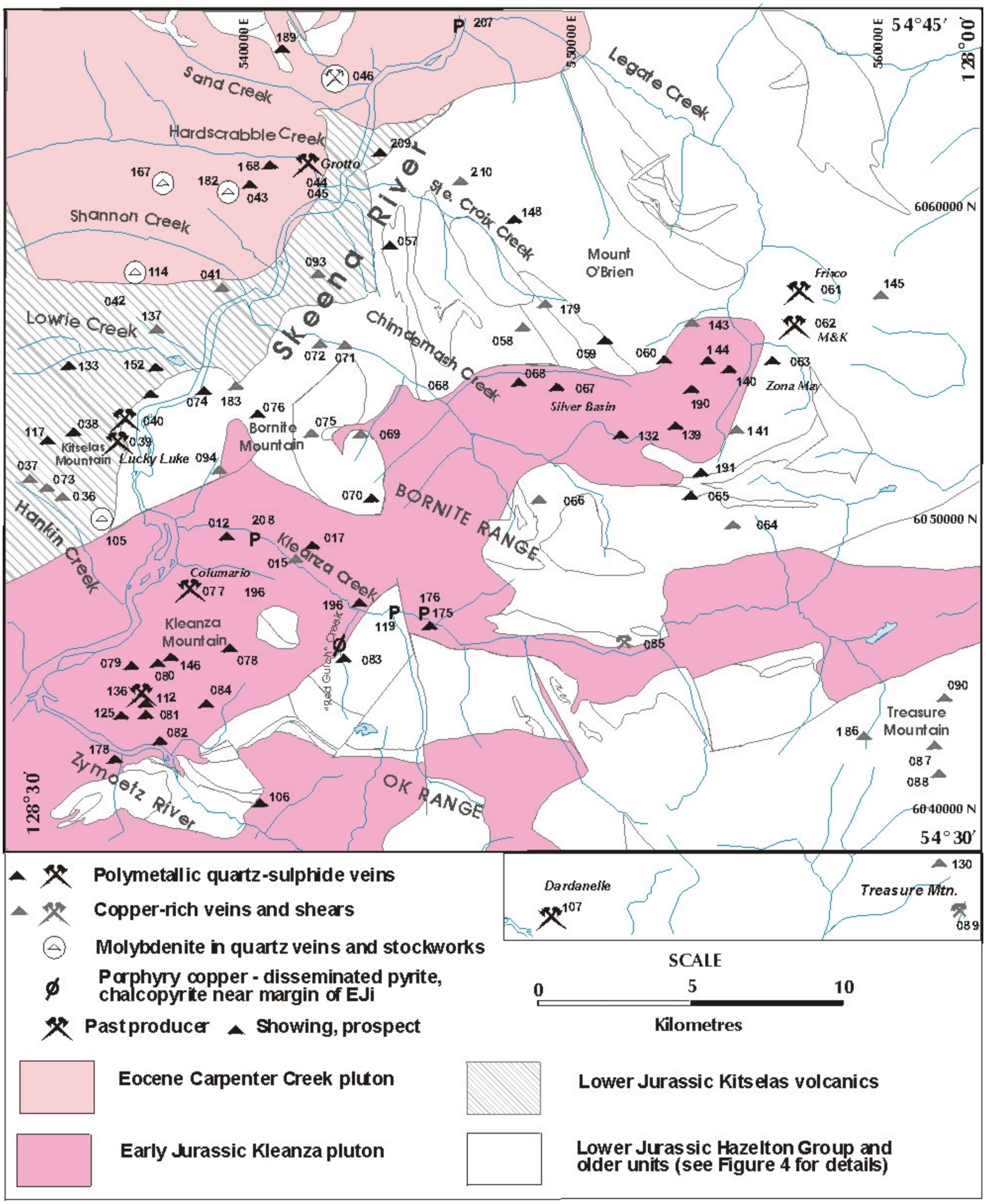

Figure 11. Mineral prospects in the Usk map area.

associated with an unusual porphyritic monzonite phase of the pluton. In 'Red Gulch' Creek and on the lower, western and southern slopes of Bornite Mountain, common occurrences of disseminated chalcopyrite and pyrite near the margins of the pluton may indicate a potential for porphyry-style mineralization.

The only cluster not clearly associated with the Kleanza pluton is that on Kitselas Mountain, including the Lucky Luke (MINFILE 103I039) and Gold Star veins (MINFILE 103I038; Carter, 1970). These crosscut S_1 fabrics in the Kitselas member, which are related to the Usk shear zone; therefore, they are probably of Eocene age and may relate to the detachment faulting event.

HIGHLIGHTS OF 2005 ROCK GEOCHEMICAL SAMPLING PROGRAM

As part of the regional mapping program, more than 70 samples were taken from mineralized zones and areas for geochemical and assay analysis (Table 2). Some correspond exactly or approximately to existing locations in the MINFILE database. Table 3 shows revised locations for selected mineral occurrences, based on the authors' work and that of Raymond Cook of Argonaut Resources.

Sampling carried out by the authors confirmed significant metal values from several known showings. Grab samples from the Columario (JN4-3; MINFILE 103I077) and Lucky Luke (JN2-5; MINFILE 103I039) returned 36.6 and 0.35 g/t Au, respectively. Many samples in the upper Chimdemash Creek area contain significant metal values, notably a vein float sample, TB-26-03, taken west of the Silver Basin (MINFILE 103I065) that contains 0.18 g/t Au. Showings on Treasure Mountain (EK 24 through 26 series; MINFILE 103I090, 086) returned high values of Cu and, in some cases, elevated Ag. The Alvija occurrence (MINFILE 103I089), located immediately north of the Kleanza Creek road, is a broad zone of fracturing and Cu mineralization. A representative sample contained 5.59% Cu and 99 g/t Ag. Quartz veins at the Shan occurrence (TB41-3, 4; MINFILE 103I167) contained up to 0.989% Mo.

Table 2 also shows many anomalies from samples not located near previously documented mineral occurrences. Although most are from thin veins and shear zones, some represent interesting new mineral potential for the area. They include the following:

- The highest Au value obtained from a new showing was 3670 ppb (3.6 g/t) from sample JN13-7, located on the ridge south of Mount O'Brien. It was obtained by digging through talus to a malachite-stained shear zone in rubble-crop. The width and length of this zone are unknown, because it is largely covered.
- Samples EK8-1 and 1a are from an outcrop on the north side of the Hardscabble Creek logging road, where several quartz veins with small, visible sulphide grains occur in a silicified zone associated with aplite dikes. The samples contain elevated values of W, Cu, Pb, Zn, Ag, Bi, Cd and Te (Table 2). The dike and vein system strike roughly east, subparallel to the road; they shortly disappear under cover in both directions. This locality is approximately 1 km west of the Grotto vein in the canyon of Hardscrabble Creek (MINFILE 103I044, 45).
- Samples from within and near the Silver Basin area tend to contain elevated base metal and silver values. These include JN7-3, JN8-2, TB26-3, TB26-6, TB26-13, TN27-5, TB27-8 and TB27-12. Combined with the widespread ankeritic alteration in the area, they indicate a significant metalliferous system.
- Samples of disseminated pyrite and chalcopyrite from near the borders of the Kleanza pluton include EK13-5, EK13-8, EK13-11, EK15-3, and TB4-2.They contain anomalous but sub-ore-grade Cu values, 419–3083 ppm, and negligible Au and Ag.
- Samples EK9-3 and 9-5, from the logging road south of Sand Creek, were of altered, quartz-veined granite of the Carpenter Lake pluton, with minor visible molybdenite. They returned anomalous Mo values of 38 and 164 ppm.

MINERAL POTENTIAL AND MODELS

Mineralization in the Usk area is controlled by the Early Jurassic Kleanza pluton, particularly its northern lobe; the Eocene Carpenter Lake pluton; possibly the Usk shear zone; and, in the case of the Cu(-Ag) occurrences on Treasure Mountain, fluid flow of unknown origin along a north-striking shear zone. The Kleanza system is generally expressed as polymetallic quartz veins and vein swarms with sporadic high values in Au and/or Ag. Replacement-style mineralization is reported in a tuff near its northeastern margin, at the Zona May occurrence (MINFILE 103I061; Salat, 2005; R. Cook, pers. comm., 2005). The widespread Silver Basin veins and alteration zones at the head of Chimdemash Creek provide a target of interest.

The Carpenter Lake pluton contains zones of molybdenite concentration, such as the Shan occurrence and the Sand Creek area.

Although, in general, the Treasure Mountain system is clearly shear related and shear controlled, there is an important zone south of the map area (MINFILE 103I090) from which stratabound zones have been reported (A. Burton, pers. comm., 2005). There, a 12.19 m surface chip sample assayed approximately 3.40% Cu and 18.6 g/t Ag (Sutherland Brown, 1965). Unclassified reserves are 28 120 tonnes grading 1.7% Cu (Sadlier-Brown, 1973). This zone offers the possibility of bulk-tonnage potential.

Exposures of Troy Ridge Formation equivalents in the northwestern corner of the map area hint at the potential for Eskay-equivalent stratigraphy along strike farther to the north.

SUMMARY AND CONCLUSIONS

Geological mapping by the BC Geological Survey in the area northeast of Terrace in 2005 has clarified stratigraphic, intrusive and structural relationships of upper Paleozoic, Triassic and Jurassic rock packages, including subdivision of the Jurassic Hazelton Group and Telkwa Formation.

It is suggested here that the Permian volcanogenic strata and limestone be informally named the Zymoetz group, as the nearest equivalent exposures (the Asitka Group and units in the Stikine 'assemblage') are 250 km distant.

The authors have recognized an unusual, volcanic-free Triassic section of black chert and basinal sedimentary strata. It, along with the underlying Permian rocks, was thrust imbricated prior to deposition of the basal conglomerate of the Lower Jurassic Telkwa Formation.

TABLE 2. GEOCHEMICAL AND ASSAY RESULTS FROM 2005 SAMPLING IN THE USK MAP AREA

					Element	Mo	W	Cu	Pb	Zn	Au	Ag	Bi	Cd	Te	As	Sb	Hg
					Units (note that assays in % and g/t are in bold)	ppm (%)	ppm	ppm (%)	ppm (%)	ppm (%)	ppb	ppb (g/tonne)	ppm	ppm	ppm	ppm (%)	ppm (%)	ppb %
					Method	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS
					Detection Limit	0.01	0.2	0.01	0.01	0.1	0.1	2	0.02	0.01	0.02	0.1	0.02	5
Station ID	Easting	Northing	Sample Description	MINFILE name	MINFILE number													
05EK03-2	536652	6041105	skarn? + chalcopyrite			0.36	-0.1	37.73	2	36.6	0.4	57	0.14	0.13	0.12	1.8	0.13	5
05EK04-1	549076	6046868	quartz vein + pyrite in microdiorite			0.96	2.3	18.92	2.18	28.4	2.2	149	1.06	0.11	0.37	0.7	0.12	5
05EK04-2	549227	6046833	quartz vein + pyrite in microdiorite			8.02	78.8	1518.63	2.5	31	17.8	1486	14.53	0.11	6.52	4.1	0.12	23
05EK08-01	540488	6062600	20 cm quartz vein in silicified aplite with pyrite, chalcopyrite, chalcocite, bornite, galena			4.17	>100	128.53	1042.78	370.5	17.4	30234	146.02	16.62	3.57	2	0.11	65
05-EK-08-01a	540488	6062600	20 cm quartz vein in silicified aplite with pyrite, chalcopyrite, chalcocite, bornite, galena			10.83	5.6	261.67	**0.41**	3137.3	41.3	**253**	646.65	159.04	19.87	2.6	21.93	204
05EK08-02	540593	6062598	quartz vein in silicified aplite with pyrite, chalcopyrite, chalcocite, bornite, galena			0.91	0.5	42.79	4.19	99	-0.2	75	0.71	0.67	0.04	1.1	0.21	13
05EK08-03	540646	6062609	quartz vein in silicified aplite with pyrite, chalcopyrite, chalcocite, bornite, galena			0.62	0.3	4.27	5.55	20.1	-0.2	69	0.39	0.06	-0.02	1.4	0.09	15
05EK08-10	543091	6062965	5 cm quartz vein with chalcopyrite wisps			61.78	0.1	2984.3	1.29	97.1	11.1	16081	1.83	1.81	0.39	-0.1	0.08	-5
05EK09-03	542074	6063990	quartz stockwork with molybdenite	Pitman	46	37.78	0.5	7.97	4.45	10.1	-0.2	227	4.39	0.06	0.33	0.6	0.12	-5
05EK09-05	541443	6064116	quartz stockwork with molybdenite	near Pitman	46	163.76	0.1	30.24	2.4	30.8	-0.2	83	1.56	-0.01	0.04	2.9	0.16	-5
05EK10-06	540517	6042837	pyritic zone at Kleanza pluton contact			1.12	-0.1	447.03	2.27	22.6	0.9	179	0.45	0.07	0.24	0.8	0.16	-5
05EK10-06rep	540517	6042837	pyritic zone at Kleanza pluton contact			0.97	-0.1	419.89	2.18	18.7	1.1	176	0.37	0.06	0.22	0.7	0.16	-5
05EK11-03	538339	6059735	altered Eocene granite with pyrite, azurite			1.92	-0.1	26.8	6.44	39.4	-0.2	264	0.76	0.06	0.13	0.5	0.06	-5
05EK13-05	543271	6046592	microdiorite with chalcopyrite, pyrite			43.58	0.3	481.64	4.21	44.6	5.9	336	0.12	-0.01	0.13	0.6	0.36	-5
05EK13-08	542834	6046628	microdiorite with chalcopyrite, pyrite			1.36	0.4	515.11	2.97	75.1	1.6	334	0.22	0.15	0.14	0.7	0.21	-5
05EK13-10	542936	6046450	microdiorite with chalcopyrite, pyrite			0.88	0.4	57.44	1.36	49.2	1	64	0.07	0.01	0.05	0.4	0.08	-5
05EK13-11	543211	6046552	andesite with chalcopyrite, pyrite			0.5	-0.1	699.52	631.29	55.9	17.4	2108	0.09	0.08	0.14	1.1	8.01	8
05EK15-03	540094	6053186	bornite with epidote alteration, quartz veining; in microdiorite			0.37	0.2	3038.05	3.32	90.2	55.2	3326	0.84	0.14	0.15	1.1	0.13	-5
05EK21-05	555527	6040284	thin quartz vein with malachite, azurite			1.45	0.2	**3.32**	7.25	38.7	6.6	**19**	0.03	2.82	0.02	1.2	0.04	74
05EK24-01	564027	6041719	Cu-stained shear zone	Treasure Mtn.	90	0.2	0.1	1409.7	10.68	130.5	0.8	1193	0.04	0.18	-0.02	2.2	0.27	6
05EK24-06	563187	6040694	Cu-stained shear zone - over 2 m wide	Treasure Mtn.	90	0.26	0.3	**5.091**	1.67	108.2	210.7	**34**	0.02	0.06	0.04	2.1	0.07	-5
05EK-24-06b	563187	6040694	second chip sample Cu-stained shear zone, 2 m	Treasure Mtn.		6.78	0.2	**1.853**	11.84	109.7	1092.2	**15**	1.36	0.39	0.06	1.6	0.85	7
05EK25-08	563061	6042263	malachite-stained andesite	Montana	88	1.17	-0.1	2597.7	40.73	79.7	13.3	1869	0.1	0.35	0.14	10.7	5.66	12
05EK26-01	563858	6042482	chalcocite+malachite in 30 cm+ shear	Treasure Mtn. - Wells showing	90	0.15	-0.1	**9.156**	3.95	101.2	339.7	**228**	0.12	0.21	0.1	0.9	0.1	65
05EK26-05	564139	6042351	bornite, chalcocite, chalcopyrite in shear	Treasure Mtn.	90	0.17	-0.1	**2.427**	1.31	76.8	136.2	**77**	0.09	0.67	0.03	1	0.13	28
05-EK-31-05	561796	6058684	1 m thick shear breccia with quartz veining			13.25	3.8	**3.2**	**0.44**	1640	364.3	10586	2.85	43.29	1.57	7.8	9.65	993
05-EK-31-05rep	561796	6058684	1 m thick shear breccia with quartz veining			13	2.9	**3.287**	**0.5**	1677.3	185.5	7714	2.78	46.16	1.4	6.9	2.93	1133
05EK35-12	561907	6062498	altered tuff with abundant malachite			0.32	-0.1	3750.53	31.78	140	13	25136	0.35	1.14	-0.02	78.7	116.86	162
05EK37-01	559887	6061626	rusty, malachite-azurite stained volcanic			0.35	-0.1	**1.341**	7.24	22.9	12.3	**270**	1.58	0.17	0.02	11.8	1.38	33
05EK41-02	562679	6043387	quartz stockwork with chalcopyrite, bornite, malachite, azurite			0.18	-0.1	2430.78	8.91	47.1	15.5	1270	0.07	0.14	-0.02	0.8	0.3	-5
05EK41-07	562848	6043929	minor chalcopyrite in shear	Copper King?	163	0.26	-0.1	118.3	0.7	14.9	6.6	447	0.02	0.06	-0.02	0.4	0.04	-5
05EK41-08	562893	6043778	20 cm shear with epidote, bornite, chalcocite, malachite, azurite	Copper King?	163	0.23	0.1	**6.116**	3.35	139	27.4	**88**	0.05	0.66	0.07	0.7	0.09	15
05JN02-5	536153	6052601	quartz vein with bornite, chalcocite, pyrite	Lucky Luke	39	17.52	1.4	**2.734**	3.68	34.2	3509.7	**70**	30.48	1.23	9	-0.1	0.09	8
05JN04-3	539757	6048084	quartz vein with coarse pyrite	Columario	77	1.23	0.1	**0.018**	7.09	28.1	38629.3	**137**	10.52	0.36	63.61	1.2	0.06	58
05JN05-3	560134	6043074	10 cm quartz vein with chalcocite, galena			0.47	-0.1	2094.4	2.23	22.7	34	1566	0.16	0.06	0.11	0.6	0.06	-5
05JN07-3	553460	6050340	20 cm quartz vein with epidote, hematite, chalcocite			0.25	<.1	**1.087**	**2.55**	**2**	113.5	**399**	0.1	778.5	0.7	**0.13**	**0.595**	**0.046**
05JN08-2	553704	6053780	quartz vein with pyrite, galena, trace chalcopyrite in altered monzonite porphyry			1.74	0.7	**0.06**	**0.53**	**1.41**	21.2	**10**	0.44	160.7	<.02	42.1	5.32	2965
05JN12-8	549820	6047287	40 cm rustry flat quartz vein			0.67	31.1	32.14	28.31	120.8	185.4	3646	23.23	0.61	11.15	8.8	0.07	18
05JN13-1	552164	6057440	frothy chalcedonic quartz vein 20 cm, irregular			0.88	0.5	41.62	5.81	113.5	1.4	475	0.95	1.78	0.05	0.8	0.09	39

TABLE 2 (CONTINUED)

					Element	Mo	W	Cu	Pb	Zn	Au	Ag	Bi	Cd	Te	As	Sb	Hg
					Units (note that assays in % and g/t are in bold)	ppm (%)	ppm	ppm (%)	ppm (%)	ppm (%)	ppb	ppb (g/tonne)	ppm	ppm	ppm	ppm (%)	ppm (%)	ppb %
					Method	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS
					Detection Limit	**0.01**	**0.2**	**0.01**	**0.01**	**0.1**	**0.1**	**2**	**0.02**	**0.01**	**0.02**	**0.1**	**0.02**	**5**
Station ID	**Easting**	**Northing**	**Sample Description**	**MINFILE name**	**MINFILE number**													
05JN13-7	551927	6056970	20 cm shear with chalcopyrite, pyrite	new showing		16.54	0.7	**5.314**	1413.18	929.7	3670	**17**	5	27.33	0.61	48.9	0.7	348
05NB04-3	536748	6044151	quartz vein with pyrite, molybdenite	New Harlequin	112	**0.214**	0.2	113	3.23	3.7	22.4	1118	0.75	0.55	0.45	0.1	0.03	30
05NB04-4	536890	6043614	coxcomb quartz vein with pyrite	Excelsior	181	9.14	3.4	733.1	9.2	81.8	959.7	13033	20.77	1.17	22.17	1	0.08	5
05NB06-4	546363	6063795	2 m fracture zone with chalcopyrite, malachite, chalcocite			0.66	0.4	2069.61	2.38	65.3	13.6	5110	2.59	0.91	0.27	0.2	0.07	-5
05-NB-07-06	545200	6062700	30 cm quartz vein with bornite			19.71	0.4	4165.32	1.88	27.5	246.9	11951	6.03	0.44	3.19	-0.1	0.28	-5
05NB10-6	540604	6045701	quartz vein in topographic linear, cryptocrystalline; stockwork			1.84	<.1	46.73	67.26	57.1	2.8	1314	0.04	1.37	0.02	3.7	8.77	1229
05NB10-8	540888	6045772	quartz stockwork			652.97	<.1	19.59	14.72	33.3	36.4	598	0.05	0.14	<.02	186	5.12	279
05NB24-3	534216	6065296	30 cm fine grained quartz vein + stockwork; in Eocene granite			0.78	-0.1	63.05	2.23	16	2.5	87	0.11	0.03	-0.02	0.2	0.03	-5
05TB03-7	552920	6046509	fractures with malachite, bornite: 20 m+wide zone	Alvija/ Lucky Jane?	85	3.23	0.1	**5.59**	36.42	184.6	14.7	**99**	0.23	1.68	0.57	1.4	0.2	660
05TB04-2	544488	6045917	disseminated pyrite in quartz veins; silicification	Kino	83	70.47	0.3	625.87	11.13	46.8	12.2	1276	0.17	0.4	0.12	1.6	1.27	7
05TB06-7	540244	6054066	flat quartz vein with pyrite, chalcopyrite, galena, sphalerite	Four Aces	76	0.3	-0.1	645.76	1433.4	6000.3	60.2	19066	9.29	195	7.79	0.1	0.04	11
05-TB-9-09	539333	6054456	quartz vein 2-3 m, with bornite, chalcocite	Emma	74	2.39	1.2	6271.25	3438.08	9155.5	43.6	61000	98.73	179.26	7.04	-0.1	1.36	16
05TB11-3	545285	6066873	1-2% visible pyrite in granodiorite			0.94	-0.1	928.45	8.92	108.8	1.2	11162	0.05	2.95	-0.02	23.4	117.19	210
05TB11-6	545706	6066895	thin quartz vein with pyrite, sphalerite, chalcopyrite			0.68	-0.1	890.26	10.14	120.5	0.7	10983	0.06	3.11	0.03	23	126.99	214
05TB13-3	541784	6050970	quartz vein with epidote alteration, chalcopyrite, bornite			1.19	0.1	9342.85	7.27	20	30.5	1754	0.21	1.84	0.74	0.6	0.56	-5
05TB13-5	541822	6050978	shear zone			0.36	-0.1	9309.3	1.61	40.9	11.3	3387	0.11	0.88	0.51	0.5	0.3	-5
05TB17-3	546337	6045678	5 m ankeritic shear zone with malachite, chalcocite			0.23	-0.1	1801.47	6.19	209.5	3.6	2820	0.07	0.07	0.02	0.8	0.78	-5
05TB22-6	557700	6044323	massive pyrite at dike margin			21.5	0.2	2222.15	8.05	21.8	9.4	840	4.22	0.03	5.22	59.8	2.15	66
05TB24-7	557660	6042014	40 cm zone of epidote veinlets with malachite, azurite, pyrite, chalcocite			0.44	0.1	**1.993**	1.7	42.5	2	8213	0.02	0.35	0.25	1.3	0.06	-5
05-TB-26-03	555087	6051416	polymetallic vein float, upper Chiimdemash Creek			4.69	17.6	**0.685**	4682.46	1326.6	1842.4	**1469**	0.5	149.35	0.02	125.3	**0.351**	2304
05TB26-6	555437	6051701	quartz veins with malachite, azurite, galena	Silver Basin	65	1.73	0.2	1362.83	8335.49	4974.6	102.4	96002	0.42	168.42	0.03	89.2	333.29	1213
05TB26-8	555673	6051584	chalcopyrite with epidote in amygdules	Silver Basin	65	0.3	<.1	66.15	12.91	196.6	1.6	603	0.03	3.9	0.02	1.4	0.73	26
05-TB-26-08	555673	6051584	barite-quartz vein 10 cm	Silver Basin	65	0.3	<.1	66.15	12.91	196.6	1.6	603	0.03	3.9	0.02	1.4	0.73	26
05-TB-26-13	555646	6051345	Main Trench vein 20 cm, with bornite, chalcopyrite, tetrahedrite	Silver Basin	65	9.04	0.5	**1.62**	79.43	1199.6	250.2	**1481**	0.28	279.63	0.03	180.7	9999	4472
05TB27-12	556713	6050629	rusty felsic dike			1.47	<.1	25.29	14.54	36.2	2.5	447	0.05	0.22	2.45	37.3	1.24	48
05TB27-5	554232	6051210	chalcocite, hematite and epidote in basalt			52.36	<.1	**1.412**	5	62.9	49	**55**	0.5	0.93	0.81	0.8	6.56	106
05TB27-8	553918	6050487	4 m patch of highly Cu-stained andesite			0.51	0.2	5418.61	12.73	65.8	0.8	4863	0.03	0.35	0.03	2.7	2.4	150
05TB39-10	559067	6065383	chalcopyrite-bornite in quartz vein breccia and epidote veins; sample is 2 - 1/2 m2 surfaces			0.7	-0.1	**4.28**	30.56	129.2	256.1	**161**	12.37	1.29	0.15	1.3	0.43	5
05TB39-10rep	559067	6065383	chalcopyrite-bornite in quartz vein breccia and epidote veins; sample is 2 - 1/2 m2 surfaces			8.27	-0.1	**4.507**	30.87	130.8	227.3	**166**	12.83	1.35	0.1	0.9	0.36	7
05TB41-3	536026	6058215	20 cm thick quartz vein with molybdenite in area of veining and disseminated pyrite-molybdenite			1328.84	0.2	115	1.24	2.9	-0.2	275	0.15	-0.01	0.04	0.1	0.04	-5
05TB41-4	536205	6058404	40 cm quartz vein with abundant pyrite, molybdenite	Shan	167	**0.989**	0.9	**0.035**	5.94	6.1	8	1380	4.88	0.26	0.53	0.4	0.11	6
05-TB-45-02	551591	6043380	one of several small sulfide (skarn?) zones in limestone olistolith within andesite tuff, each less than 30 cm wide			5.79	0.3	**1.123**	**1.28**	**10.94**	26.5	**2232**	0.43	1765.02	0.06	387.7	**0.686**	7393

TABLE 3. REVISIONS OF MINERAL DEPOSIT LOCATIONS FROM FIELD OBSERVATIONS, USK MAP AREA

MINFILE name	MINFILE number	Station	New easting	New northing	Description
Gold Star B zone	38	05JN11-2	534294	6053101	trench with quartz veins, chalcocite, bornite, chalcopyrite
Gold Star A zone	38	05JN11-3	534555	6052629	trench with quartz veins, chalcocite, bornite, chalcopyrite
Lucky Luke	39	05JN02-5	536153	6052601	quartz vein with bornite, chalcocite, pyrite
Pitman	46	05EK09-03	542074	6063990	quartz stockwork with molybdenite
Pitman	46	05EK09-05	541443	6064116	quartz stockwork with molybdenite
United St. Croix	59	05JN07-9	551722	6049346	complex quartz vein up to 1 m, with chalcopyrite, pyrite, chalcocite, malachite, azurite
Silver Basin main trench	65	05TB26-13	555646	6051345	quartz vein 20 cm with chalcocite, bornite; in WSW-striking shear zone
Emma	74	05TB09-9	539333	6054456	malachite-stained quartz veins in fault
Four Aces	76	05TB06-7	540244	6054066	flat quartz vein with pyrite, chalcopyrite, galena, sphalerite
Columario	77	05JN04-3	539757	6048084	quartz vein with coarse pyrite
Zymoetz	82	05NB04-5	536999	6043038	70 cm quartz vein with pyrite, galena, magnetite, sphalerite, chalcopyrite; in old adit
Kino	83	05TB04-2	544488	6045917	disseminated pyrite in quartz veins; silicification
Kino	83	05EK13-05	543271	6046592	microdiorite with chalcopyrite, pyrite
Kino	83	05EK13-08	542834	6046628	microdiorite with chalcopyrite, pyrite
Kino	83	05EK13-10	542936	6046450	microdiorite with chalcopyrite, pyrite
Kino	83	05EK13-11	543211	6046552	andesite with chalcopyrite, pyrite
Alvija	85	05TB03-7	552920	6046509	fractures with malachite, bornite; wide zone
Wells	87	05EK26-01	563858	6042482	chalcocite+malachite in 30 cm+ shear
Montana	88	05EK25-08	563061	6042263	malachite-stained andesite
Treasure Mtn. north	90	05EK24-06	563187	6040694	Cu-stained shear zone; over 2 m wide
New Harlequin	112	05NB04-3	536748	6044151	quartz vein with pyrite
Shan	167	05TB41-4	536205	6058404	40 cm quartz vein with abundant pyrite, molybdenite
Copper King	163	05EK41-08	562893	6043778	20 cm shear with epidote, bornite, chalcocite, malachite, azurite
Excelsior	181	05NB04-4	536890	6043614	coxcomb quartz vein with pyrite
Peerless	186	05JN06-3	560746	6044270	massive chalcocite vein in ankerite-altered andesite; 10 cm thick; flat dip
GPS locations of mineral occurrences established by Raymond Cook (pers. comm., 2005):					
Silver Basin headwall zone	65b		556552	6051171	disseminated tetrahedrite, bornite in amygdules
Pass	new		559633	6056738	gossan (breccia zone) 40 m wide, continuous 200 m in pass; assays pending
Frisco	61		558656	6058339	Cu, Ag in veins, stringers, disseminations in 12 m wide zone (MINFILE)
M&K main adit	62		558609	6057003	Quartz veins with Au, Ag values (0.38 g/t Au, 119 g/t Ag in grab sample; Salat, 2005) in sheared, brecciated zone
M&K (stratabound zone)	62b		558577	6056985	bedding-parallel mineralized zone, up to 1.2 m wide, in tuff; chalcopyrite, chalcocite, galena, bornite, minor tetrahedrite, pyrite, specularite
Zona May vein	60a		554523	6055208	0.2 3 m wide quartz vein over 700 (possibly 1800) m; strikes ESE; grab samples assayed 0.03 24 g/t Au, 0.3 3364 g/t Ag (Salat, 2005)
Zona May west wall breccia	60b		554296	6055299	see above
Zona May vein (glacier zone)	60c		554631	6055172	see above
Zona May east	60d		554674	6055172	see above
Dynasty	new		555343	6055033	extension of Zona May vein to east(?); east-striking quartz vein with Cu, Ag

The Telkwa Formation is regionally divisible into two distinct successions: a clastic-dominated section south of Kleanza Creek, and a flow-dominated succession north of Kleanza Creek. Although the flow-dominated section locally overlies the clastic section, the authors consider them to be volcanic facies variants as well: the flows were sourced locally within the map area and represent a major complex of andesite, dacite and rhyolite centres.

The Kitselas facies of the Telkwa Formation comprises mainly felsic volcaniclastic and coherent rocks, with minor basalt; it lies in the footwall of the Usk fault.

The top of the Hazelton Group comprises an equivalent of the 'Red Tuff' member of the Nilkitkwa Formation, sandstone fossil-dated as Bajocian, and banded siliceous strata equivalent to the Troy Ridge Formation. These are overlain by the Bowser Lake Group.

The 200 Ma Kleanza pluton is a sprawling laccolithic body with two major lobes. It is probably comagmatic with the Telkwa Formation, and may core the volcanic centre that generated flows in the Mount O'Brien section.

Mineralization in the area relates to the Kleanza pluton and the Eocene Carpenter Lake pluton, as well as possibly to the structures associated with the Usk shear zone and, in the case of Cu-Ag-rich shears and replacements, regional hydrothermal circulation in the Telkwa Formation.

ACKNOWLEDGMENTS

Glenn Woodsworth was generous with his knowledge of Terrace area geology, and it was our pleasure to confirm many of his observations and ideas in the field. Bill McRae, Jim Mulvey, George Chinn, Alex Burton and Ray Cook provided detailed information on mineral prospects in the area. We are deeply indebted to Bill and Helene McRae for every kind of help and support. This project was conducted in partnership with the Resource Management Department of the Kitselas First Nation. We thank Daniel Parker, Chad Gerow and Richard Seymour for able assistance in the field. Larry Diakow provided an insightful review of the text.

REFERENCES

Alldrick, D.J., Nelson, J.L. and Barresi, T. (2005): Geology and mineral occurrences of the upper Iskut River area: tracking the Eskay rift through northern British Columbia; *in* Geological Fieldwork 2004, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 2005-1, pages 1–30.

Anderson, R.G. (1989): A stratigraphic, plutonic and structural framework for the Iskut map area, northwestern British Columbia; *in* Current Research, Part E, *Geological Survey of Canada*, Paper 89-1E, pages 145–154.

Barresi, T. and Nelson, J.L. (2006): The Usk map area near Terrace, BC: Cross-sections and volcanic facies interpretation; *in* Geological Fieldwork 2005, *BC Ministry of Energy,* *Mines and Petroleum Resources*, Paper 2006-1 and *Geoscience BC*, Report 2006-1.

Bennett, N., Compiler (1997): Pioneer Legacy: Chronicles of the Lower Skeena River; *R.E.M. Lee Hospital Foundation*, Terrace, BC, 240 pages.

Berthiaume, R. (1999): The Gitselasu: The People of Kitselas Canyon; *First Nations Education Centre*, Terrace, BC, 154 pages.

Brown, D.A., Gunning, M.H. and Greig, C.J. (1996): The Stikine Project: geology of western Telegraph Creek map area, northwestern British Columbia; *BC Ministry of Energy, Mines and Petroleum Resources*, Bulletin 95, 176 pages.

Carter, N.C. (1970): Gold Star; *in* Geology, Exploration and Mining in British Columbia 1970, *BC Ministry of Energy, Mines and Petroleum Resources*, pages 195–197.

Duffell, S. and Souther, J.G. (1964): Geology of Terrace map area, British Columbia; *Geological Survey of Canada*, Memoir 329, 117 pages.

Gareau, S.A., Friedman, R.M., Woodsworth, G.J. and Childe, F. (1997a): U-Pb ages from the northeastern quadrant of Terrace map area, west-central British Columbia; *Geological Survey of Canada*, Current Research 1997-A/B, pages 31–40.

Gareau, S.A., Woodsworth, G.J. and Rickli, M. (1997b): Regional geology of the northeastern quadrant of Terrace map area, west-central British Columbia; *Geological Survey of Canada*, Current Research 1997-A/B, pages 47–55.

Gunning, M.H., Bamber, E.W., Brown, D.A., Rui, L., Mamet, B.L. and Orchard, M.J. (1994): The Permian Ambition Formation of northwestern Stikinia, British Columbia; *in* Pangea: Global Environments and Resources, Embry, A.F., Beauchamp, B. and Glass, D.J., Editors, *Canadian Society of Petroleum Geologists*, Memoir 17, pages 589–619.

Heah, T.S.T. (1991): Mesozoic ductile shear and Paleogene extension along the eastern margin of the Central Gneiss Complex, Coast Belt, Shames River area, near Terrace, British Columbia; M.Sc. thesis, *University of British Columbia*, Vancouver, BC, 155 pages.

Kindle, E.D. (1937a): Mineral resources of Terrace area, Coast district, British Columbia; *Geological Survey of Canada*, Memoir 205.

Kindle, E.D. (1937a): Mineral resources, Usk to Cedarvale, Terrace area, Coast district, British Columbia; *Geological Survey of Canada*, Memoir 212.

Logan, J.M., Drobe, J.R. and McClelland, W.C. (2000): Geology of the Forrest Kerr – Mess Creek area, northwestern British Columbia; *BC Ministry of Energy, Mines and Petroleum Resources*, Bulletin 104, 164 pages.

Marsden, H. and Thorkelsen, D.J. (1992): Geology of the Hazelton volcanic belt in British Columbia: implications for the Early to Middle Jurassic evolution of Stikinia; Tectonics, Volume 11, pages 1266–1287.

Mihalynuk, M.G. (1987): Metamorphic, structural and stratigraphic evolution of the Telkwa Formation, Zymoetz River area (NTS 103I/08 and 93L/05), near Terrace, British Columbia; M.Sc. thesis, *University of Calgary*, Calgary, Alberta, 128 pages.

Mihalynuk, M.G. and Friedman, R.M. (2005): Gold and base metal mineralization near Kitsumkalum Lake, north of Terrace, west-central British Columbia; *in* Geological Fieldwork 2004, *BC Ministry of Energy, Mines and Petroleum Resources*, Paper 2005-1, pages 67–82.

MINFILE (2005): MINFILE BC mineral deposits database; *BC Ministry of Energy, Mines and Petroleum Resources*, URL <http://www.em.gov.bc.ca/mining/Geolsurv/Minfile/> [Nov 2005].

Monger, J.W.H., Wheeler, J.O., Tipper, H.W., Gabrielse, H., Harms, T., Struik, L.C., Campbell, R.B., Dodds, C.J., Gehrels, G.E. and O'Brien, J.A. (1991): Cordilleran terranes; Part B of Chapter 8 *in* Geology of the Cordilleran Orogen in Canada, Gabrielse, H. and Yorath, C.J., Editors, *Geological Survey of Canada*, Geology of Canada, No 4, p. 281–328 (also The Geology of North America, *Geological Society of America*, Boulder, Colorado, Volume G-2).

Nelson, J.L., Barresi, T., Knight, E. and Boudreau, N. (2006): Geology of the Usk map area, Terrace, British Columbia (193I/09); B.C. Ministry of Energy, Mines and Petroleum Resources, Open File 2006-3, 1:50,000 scale.

Roots, C.F., Nelson, J.L., Simard, R.-L., Mihalynuk, M., Harms, T.A., Friedman, R. and Heaman, L. (in press): Continental fragments, Paleozoic arcs and overlapping Triassic sediments in the pericratonic belt, northern British Columbia and southern Yukon; *in* Paleozoic Evolution and Metallogeny of Pericratonic Terranes at the Ancient Pacific Margin of North America, Canadian and Alaskan Cordillera, Colpron, M., Nelson J.L. and Thompson, R.I., Editors, *Geological Association of Canada*, Special Paper 45, in press.

Sadlier-Brown, T. (1973): Statement of material facts — Treasure Mountain; press release, prepared for *Spectroair Explorations Ltd*, June 16, 1973.

Salat, H.P. (2005): Report on the geological reconnaissance and evaluation of the Zona May – Silver Basin property, BC; submitted by Argonaut Resources Inc., *BC Ministry of Energy, Mines and Petroleum Resources*, AR 27786, 90 pages.

Sutherland Brown, A. (1965): Northwest Copper – Treasure Mountain; *BC Ministry of Energy, Mines and Petroleum Resources*, Minister of Mines Annual Report 1965, pages 71-72.

Tipper, H.W. and Richards, T.A. (1976): Jurassic stratigraphy and history of north-central British Columbia; *Geological Survey of Canada*, Bulletin 270, 73 pages.

van der Heyden, P. (1992): A Middle Jurassic to early Tertiary Andean-Sierran subduction model for the Coast Belt of BC; *Tectonics*, Volume 11, pages 82–97.

Woodsworth, G.J., Anderson, R.G. and Armstrong, R.L. (1991): Plutonic regimes; Chapter 15 *in* Geology of the Cordilleran Orogen in Canada, Gabrielse, H. and Yorath, C.J., Editors, *Geological Survey of Canada*, Geology of Canada, No 4, pages 491–531 (also *Geological Society of America*, The Geology of North America, Volume G-2).

Woodsworth, G.J., Hill, M.L. and van der Heyden, P. (1985): Preliminary geology map of Terrace (NTS 103I, east half) map area, BC; *Geological Survey of Canada*, Open File 1136, 1 map at 1:125 000 scale.