Terrace Regional Mapping Project Year 2: New Geological Insights and Exploration Targets (NTS 103I/16S, 10W), West-Central British Columbia

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INTRODUCTION

The 2006 field season was a continuation of regional geological mapping and mineral deposit studies in the area north of Terrace, extending north and west of the Usk map area, which was completed in 2005 (Fig 1; Nelson *et al.*, 2006a, b).

The area covered was the south half of the Doreen map sheet, NTS 103I/16, and the east half of the Terrace map sheet, NTS 103I/10.

The most important geological observations include

- the recognition and definition of a stratigraphic marker sequence at the top of the Hazelton Group, which corresponds in position, and possibly in age, to the rocks that host the Eskay Creek mine; and
- the establishment of stratigraphic offsets that constrain both normal motion and precursor thrust motion on the low-angle fault or faults that border the uplifted Kitselas metamorphic complex.

Key economic findings include

- a new zone of copper mineralization that was discovered over a significant area near the Borden Glacier on the north side of Mt Sir Robert; probably related to, but distinct from, previously known showings; and
- the discovery that the southern slopes of Mt Knauss have been affected by a large alteration system cored by a zone of porphyry-style molybdenum-copper mineralization (Womo, MINFILE 103I 122); this interesting area is currently staked but has had no recent exploration activity.

GEOLOGY

The Terrace, Usk and Doreen map areas are contiguous and the same geological issues arise throughout. Therefore, this treatment, although focused on geological units examined during 2006, also refers to the geology included in last year's map coverage (Nelson *et al.*, 2006a) for completeness. It should also be noted that our detailed mapping succeeds regional work by G. Woodsworth and colleagues (Woodsworth *et al.*, 1985; Gareau *et al.*, 1997a, b; G. Woodsworth, 1:100 000 mapping, pers comm), which has provided an invaluable framework for subsequent study.

Tectonically, the area is divided into two distinct structural panels by gently to steeply east-dipping faults in the valley of the Skeena River, termed here the Skeena River fault zone. In the hangingwall of these faults, east of the Skeena River, is a stratigraphic sequence that ranges in age from Early Permian to Late Jurassic (Fig 2, 3).

From base to top, it includes the Permian Zymoetz Group (Nelson *et al.*, 2006a), overlain by extensive exposures of the mainly subaerial volcanic Howson facies of the Telkwa Formation, which is a thin but continuous marker unit of Middle (?) Jurassic clastic Smithers Formation, and chert – siliceous argillite – felsic tuff comparable to the 'pyjama beds' of the upper Hazelton Group in the Iskut area, and the Bowser Lake Group. This sequence is typical of much of Stikinia. The Telkwa and Smithers formations and the pyjama beds belong to the Early to Middle Jurassic Hazelton Group. Early Jurassic and older stratified rocks are intruded by the Early Jurassic Kleanza pluton. Between the Skeena River and the Kitsumkalum River valley, the footwall of the fault system comprises a somewhat different stratigraphic sequence of felsic and minor basaltic strata of the Early Jurassic Kitselas facies, overlain by a thin interval of more typical Telkwa varied volcanic units, the Smithers Formation, pyjama beds and the Bowser Lake Group. This panel is intruded by a strongly deformed granitoid suite of Paleocene age (the Kitsumkalum suite of Gareau *et al.*, 1997a, b). Undeformed Eocene granite, such as the Carpenter Creek and Newtown Creek plutons, cut the hangingwall and the footwall, as well as the faults that separate them. Metamorphic grades in the hangingwall panel range from zeolite facies to a narrow zone of greenschist along its base, whereas grades in the footwall panel increase from lower to upper greenschist toward the west.

The Kitsumkalum valley is part of a north-trending graben structure extending from Kitimat to the Nass valley. Within it, there are weakly metamorphosed stratified rocks of the Hazelton, Bowser Lake and Skeena groups, juxtaposed along steep faults against the Kitselas facies and deformed granitoid rocks in the mountains north of Terrace.

Stratified Units

TELKWA FORMATION EAST OF THE SKEENA RIVER

The upper part of the Early Jurassic Telkwa Formation extends north from exposures mapped in Legate Creek in 2005 (Fig 4; Nelson *et al.*, 2006a, b), into the area of Mt Sir Robert, Mt Quinlan and the upper reaches of Big Oliver Creek.

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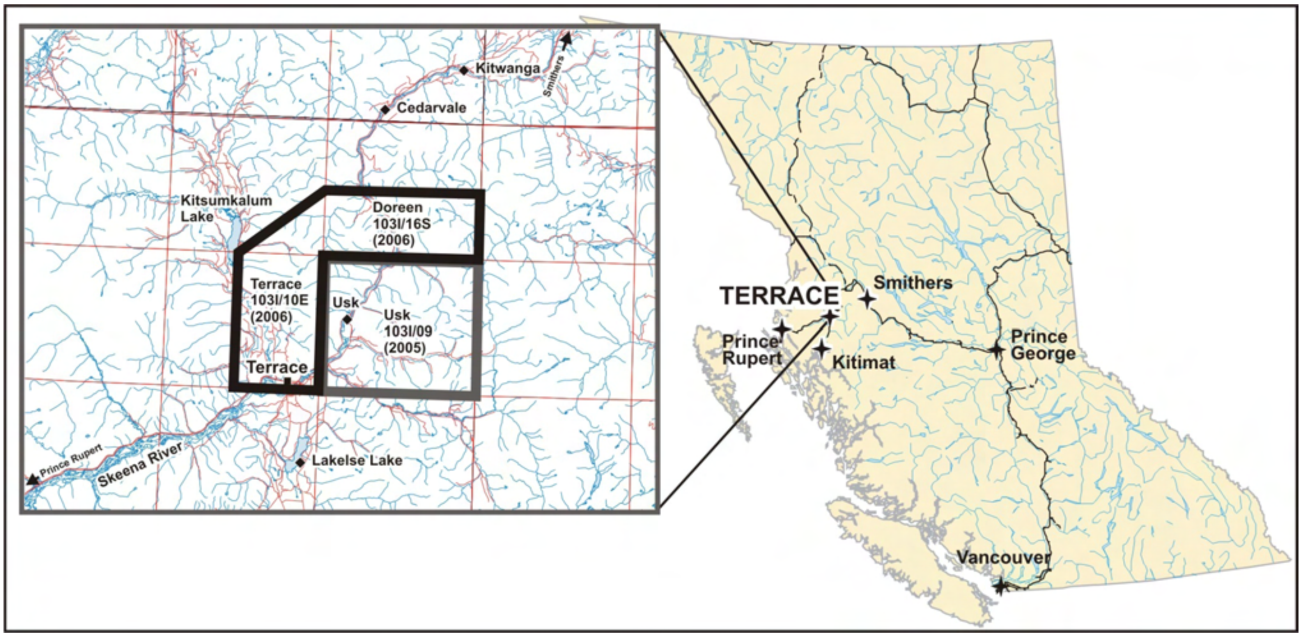

Figure 1. Location of the Terrace area in northwest BC, with current and 2005 mapping highlighted (shown in detail in Fig 2).

Farther south, it comprises flows and lesser tuff. Mt Sir Robert is composed mainly of andesitic rocks, while ridges to the south and west are underlain by more siliceous dacite. There is very little interbedding of intermediate and felsic compositions, perhaps because they were erupted from separate centres. The andesite on Mt Sir Robert is maroon to purple in colour and is generally aphanitic and often amygdaloidal. Amygdules in these flows are filled with calcite and sub-greenschist minerals such as prehnite± pumpellyite. Overall, the andesite is thickly bedded; bedding orientations can be determined by the occurrence of a minor, thinly bedded felsic strata as well as from the flattening of vesicles parallel to bed orientations. Dacitic rocks on the low ridge immediately north of Legate Creek are maroon to red and aphanitic to porphyritic. Most are coherent and probably make up a dome complex. Subsidiary welded tuff beds with strong eutaxitic fabrics provide local bedding control. Thickly bedded dacite flows and tuff also underlie the western slopes of Mt Quinlan and upper Big Oliver Creek.

The uppermost units of the Telkwa Formation, north and west of Mt Sir Robert, are brick red to maroon, rarely bright green, finely comminuted and, in part, laminated tuff that is at least partially of ignimbritic origin. Locally, thin limestone layers are intercalated with the tuff over an interval of 10 to 20 m. This tuffaceous sequence could be part of the red tuff member of the Smithers Formation (Tipper and Richards, 1976); however, it appears to be continuous with and related to dacite of the underlying Telkwa Formation rather than to the overlying, very different, clastic Smithers Formation. The stratigraphically highest unit in the Telkwa Formation is a distinctive, thickly bedded, very fine grained maroon tuff unit. Characteristically, it contains crudely planar concentrations of fist to cantaloupe-sized, ovoid to irregular, concentrically zoned clasts (Fig 5). It forms a continuous layer from the plateau north of Mt Sir Robert, to the west side of Mt Quinlan, a total of 10 km of strike length.

Stratified rocks around the lower portions of Little and Big Oliver Creek, and the northwestern part of the low ridge north of Legate Creek, are separated from the Mt Sir Robert – Mt Quinlan section by a set of steep faults. In this area, the Hazelton Group is dominated by light grey dacite and/or rhyolite, predominantly coherent and monotonous, but with some lapilli and welded lapilli tuff. Dark green aphanitic basalt is also present. As discussed by Gareau *et al*. (1997a, b), the affinity of these rocks is uncertain. In terms of lithological composition — the predominance of very felsic compositions with minor mafic units — they are similar to the Kitselas facies farther south. However, they are only sporadically foliated, and greenschist-facies mineral development is very subtle. Also, they occupy a distinct structural panel from the Kitselas facies, which merges structurally into the upper Hazelton Group near Legate Creek (Fig 2). For these reasons, we consider them part of the main Hazelton Group, as suggested by Gareau *et al.* (1997b). If they are, then the suggested tie between the *ca.* 195 Ma Kitselas facies and the Telkwa Formation (Gareau *et al*., 1997a, b) is considerably strengthened.

KITSELAS FACIES AND TELKWA FORMATION WEST OF THE SKEENA RIVER

Predominantly felsic volcanic rocks of the Kitselas facies occupy a broad region north of Terrace, spanning Kitselas Mountain, Mt Vanarsdoll, Lean-to Mountain and the high ridges in the headwaters of Hardscrabble Creek. On Kitselas Mountain, as previously described (Nelson *et al.*, 2006a), they are well-bedded pale grey to white rhyolite volcaniclastic units with some coherent flows or domes. Welded tuff with strong eutaxitic fabrics is locally well developed. Two prominent bands of dark green metabasalt strike east-northeast on the southern slope of Mt Vanarsdoll. They are the faulted equivalent of similar intervals on Kitselas Mountain, across a set of north-striking dextral faults with 500 to 1000 m offsets (Fig 2). The wider one is approximately 200 m thick. Although these rocks exhibit greenschist-facies alteration, original textures are well preserved. These include amygdaloidal and scoriaceous textures in flows, and fragmental textures in

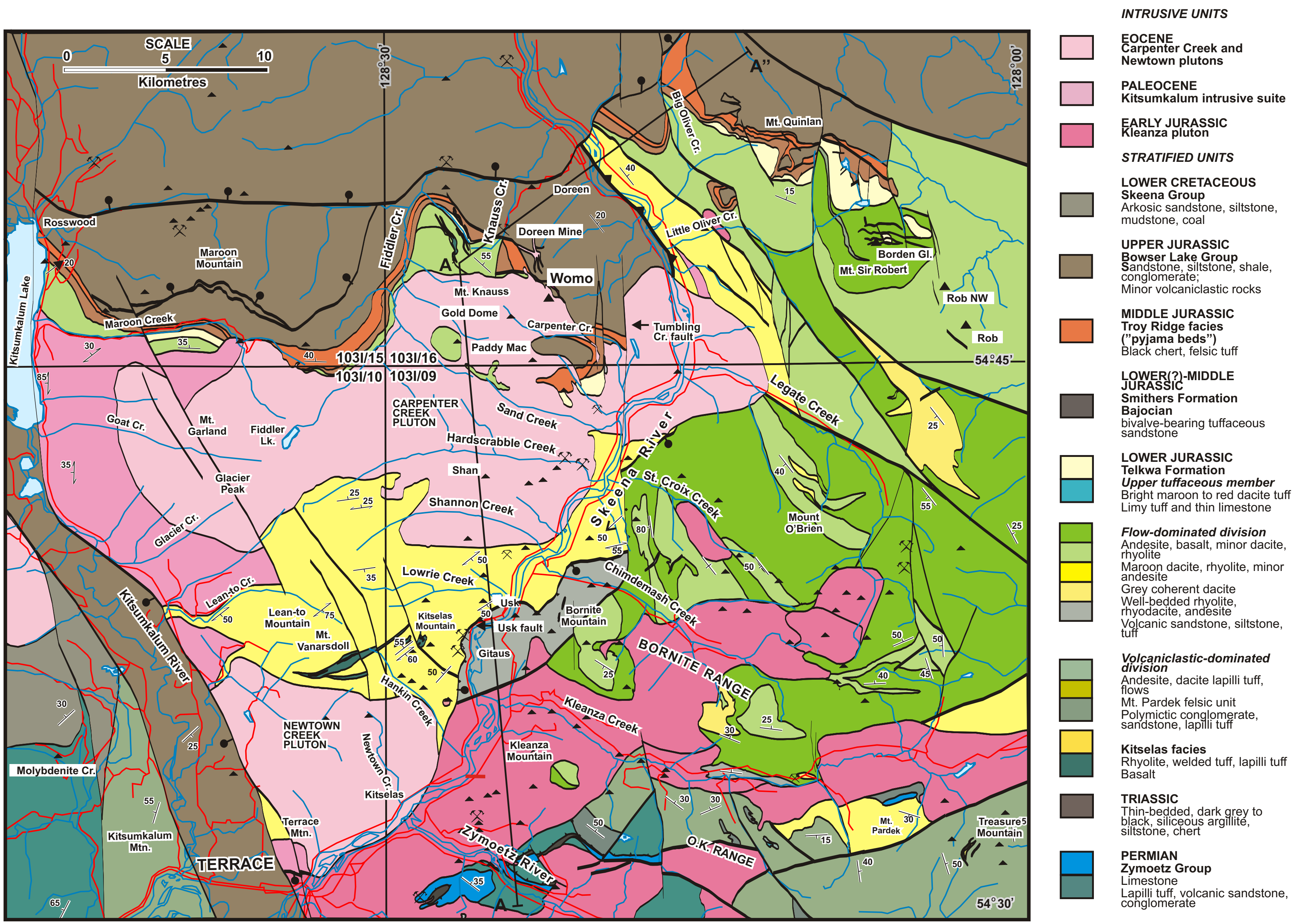

Figure 2. Geology of the Usk (NTS 103I/09), southern Doreen (NTS 103I/16) and eastern Terrace (NTS 103I/10) map areas, from field mapping in 2005 and 2006, compilation from 1:100 000 maps of G. Woodsworth (pers comm) and extrapolation of some faults and contacts.

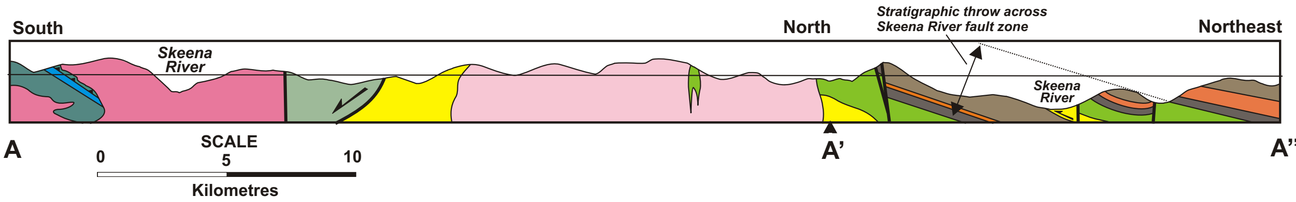

Figure 3. Cross-section of units in the Terrace area; A-A'-A'' on Fig 2; legend is the same as Fig 2.

basalt and mixed basalt-rhyolite tuff. One very small enclave on the eastern ridge of Lean-to Mountain consists of highly plagioclase-phyric, in part amygdaloidal, andesite. It is identical in texture to andesite in the upper Telkwa Formation near Mt O'Brien, even to the common clumping of tabular plagioclase into aggregates with ragged terminations. This provides further evidence of a linkage between the coeval, but for the most part compositionally distinct, Kitselas and Telkwa formations.

Overall, the Kitselas facies represents a very large felsic centre, measuring at least 15 km in the north-south dimension and 20 km east-west, which takes the place of the upper Telkwa andesite and dacite flows east of the Skeena River. It is unusual within the Telkwa for its size, uniformity and predominance of very felsic rocks; however, other smaller rhyolitic centres occur within the Telkwa Formation in the Usk area (Nelson *et al*., 2006a, b).

Near the northern exposed limit of the Kitselas facies in the Hardscrabble Creek headwaters, where it is cut off by Eocene granite, layering dips primarily to the north, projecting below a section of variably metamorphosed Telkwa volcanic units that is, in turn, overlain by the Smithers Formation and the pyjama beds. The Telkwa rocks outcrop from near Carpenter Creek through Mt Knauss and the headwaters of Maroon Creek north of Fiddler Lake, and as far west as the eastern shore of Kitsumkalum Lake. Regional metamorphic grades increase from sub-greenschist in the east to upper greenschist near Kitsumkalum Lake, but primary compositions and textures are discernible throughout. Near Carpenter Creek, a very limited Telkwa section is truncated by Eocene granite. It consists of maroon to brick red, in part finely laminated tuff. These strata were assigned to the red tuff member of the Smithers Formation by Nelson *et al*. (2006a, b), but based on observations near Mt Sir Robert, we now consider them to be the uppermost unit of the Telkwa Formation.

On eastern Mt Knauss, grey rhyolite with tiny, sparse feldspar phenocrysts is overlain by well-foliated dacite tuff and lesser basalt, a section that exhibits a degree of similarity to the Kitselas facies. The uppermost unit is a red tuff that contains planar concentrations of large, concentrically zoned clasts and is equivalent to the uppermost tuff unit east of the Skeena River. A more metamorphosed version of this unit occurs at the top of the Telkwa Formation in the headwaters of Maroon Creek. There, the clasts are replaced by concentrically zoned epidote-garnet-quartz-piedmontite(?) metadomains (Fig 6). Altogether, this unit has been recognized over a total of nearly 30 km of strike, not taking into account structural repetition across the Skeena River.

Farthest west, near Maroon Creek and along the highway east of Kitsumkalum Lake, the upper Telkwa Formation consists of green metabasalt and metadacite, generally coherent with lesser volcaniclastic textures.

SMITHERS FORMATION

The Smithers Formation lies stratigraphically between the Telkwa Formation and the pyjama beds in both the hangingwall and footwall of the fault system along the Skeena River. In the hangingwall, it is well exposed from north of Mt Sir Robert, south and west of Mt Quinlan, and in the low hills north of Big Oliver Creek. Its basal contact is sharp and paraconformable on maroon Telkwa tuff. The Smithers Formation is a uniform, well-bedded unit of light green tuffaceous volcanic-derived greywacke, with thin interbeds of tuffaceous siltstone. A high content of rhyolitic

Figure 4. Looking south across Legate Creek at the north face of Mt O'Brien, a spectacular exposure of the steeply southwest-dipping andesite of the Telkwa Formation.

Figure 5. Concentrically zoned clasts in uppermost tuff unit of the Telkwa Formation. Made of fine clastic layers, they may be cannibalized from unconsolidated ash deposits.

ash tuff gives a white cast to the weathered alpine exposures. Tiny feldspar grains are dispersed in the sand and locally white, subangular to subrounded rhyolitic pebbles occur. Curiously, no reddish dacitic or andesitic debris attributable to the underlying Telkwa Formation is present; this probably indicates a low relief environment. Fossiliferous beds and coquina, burrows and bioturbation are common. Black, petrified tree trunks, up to 30 cm in diameter, are also present in the area. Macrofossil species include large, smooth-shelled clams, trigoniids, small ribbed bivalves, gastropods and rare ammonites. Some large clams are preserved open with their shells still attached. They supported colonies of small corals, gastropods and bryozoans, the open shell providing both shelter and a food source. The thoroughness of the bioturbation suggests that the Smithers Formation accumulated on a shallow seafloor (P. Mustard, pers comm, July 2006). The rhyolitic ash and sparse small volcanic lithic clasts were probably derived from active contemporary felsic centres farther to the south, for instance, in the Whitesail and Nechako regions of south-central Stikinia (L. Diakow, pers comm, August 2006; Diakow and Levson, 1997).

The age of the Smithers Formation, east of the Skeena River, is constrained at present by a single macrofossil collection of Aalenian age (G. Woodsworth and H.W. Tipper, unpublished data, 1985). Our collections made in 2006 have not yet been identified.

In the footwall sequence west of the Skeena River, the Smithers Formation lies paraconformably above the Telkwa Formation and below the pyjama beds from Carpenter Creek to Kitsumkalum Lake (Fig 2). A collection of bivalves from sandstone near Carpenter Creek was identified as of probable Early Bajocian age, similar to faunas in the Smithers Formation on Hudson's Bay Mountain and in the Whitesail area (T. Poulton *in* Nelson *et al*., 2006a). Similar fossiliferous sandstone continues to the west across Mt Knauss. On the western side of Fiddler Creek, the metamorphic grade increases; fossils become streaks of coarse calcite, and bioturbation is recognized in uneven textures within the metasandstone. In its farthest western exposure where the highway cuts along Kalum Lake, the Smithers Formation is a glossy, pale green sericite-chlorite schist with epidote laminae replacing limy layers and spotty cordierite perhaps nucleating in burrows. Its thick, regularly bedded character persists within the outcrops of these metamorphic rocks.

PYJAMA BEDS (TROY RIDGE FACIES)

This thin but distinctive formation lies between the Smithers Formation and the base of the Bowser Lake Group in the hangingwall and footwall panels both east and west of the Skeena River. It consists of black, rusty-weathering, ribbon-bedded chert and black siliceous argillite (Fig 7a). Its siliceous nature serves to separate it from the underlying greywacke of the Smithers Formation, although there is a transitional contact in which the uppermost Smithers Formation becomes more thinly bedded and more siliceous tens of metres below its upper contact. The pyjama beds are also distinct from the overlying, non-siliceous, fine-grained to coarse-grained clastic strata of the Bowser Lake Group. Most distinctive of this unit, although not observed everywhere within it, are pale pink to white, very thin felsic tuff laminations (Fig 7b). The black and white striping is comparable to the so-called 'pyjama beds' that lie at the top of the Hazelton Group in the Iskut region, for instance, at Troy Ridge (*cf.* Anderson and Thorkelsen, 1990). The Troy Ridge facies has been dated as Bajocian (*ca.* 175 Ma; K. Simpson and V. McNicoll, pers comm,

Figure 6. Epidote metadomains in greenschist-facies dacite, in the uppermost Telkwa Formation northeast of Fiddler Lake. These are interpreted as metamorphosed equivalents of concentrically zoned bombs (*see* Figure 5).

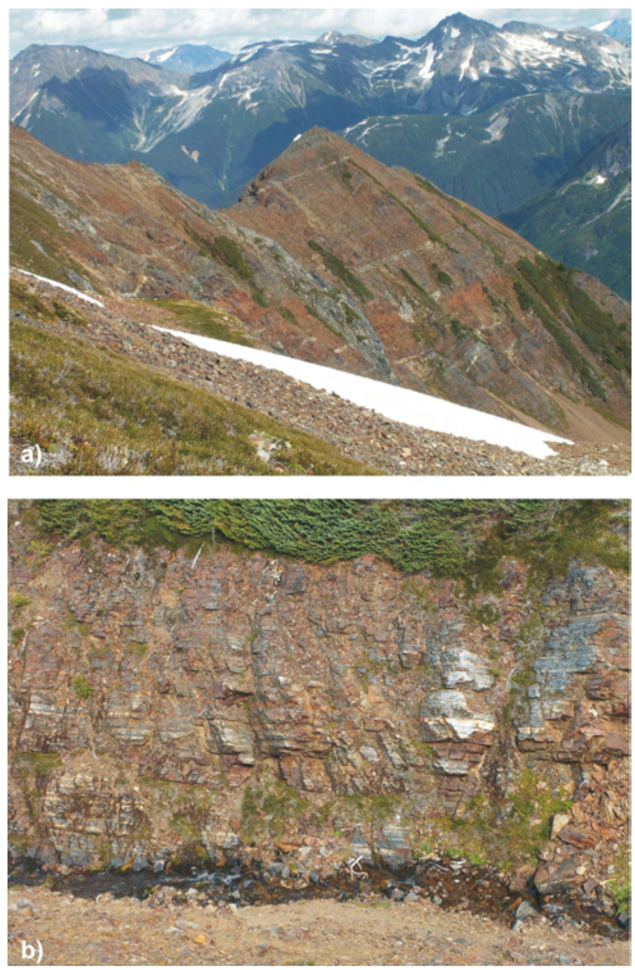

Figure 7. a) Ridge-top exposure of pyjama beds northeast of Fiddler Lake; b) close-up of pyjama beds in the saddle south of Maroon Mountain, showing their distinct and characteristic pale striping on millimetre to centimetre scales.

2005). It represents quiescent conditions at the end of the Hazelton arc cycle and is contemporaneous with the development of the Eskay Rift to the west.

The precise age of the pyjama beds in the Terrace area is not known. The unit is underlain by the Aalenian to Bajocian Smithers Formation and is overlain by the Bowser Lake Group, which locally contains fossil collections as old as Callovian (G. Woodsworth and H.W. Tipper, unpublished data, 1985). Thus it may be entirely coeval with the Troy Ridge facies, but could conceivably be as young as Early Callovian. A 2006 macrofossil collection made near the top of this unit will be a useful indicator to confirm or weaken its correlation with the Troy Ridge facies.

In any event, geological mapping in the Terrace area during 2006 traced out a unit identical in character and stratigraphic position to the Troy Ridge facies, which outcrops over a 30 km strike length from the plateau north of Mt Sir Robert to the east side of Kalum Lake. It indicates that the same deep-water, quiescent environment existed in this region at the end of the Hazelton arc volcanism similar to the Iskut area, some 200 km north of Terrace. So far, no remnant of an Eskay-like rift facies with coarse clastic and bimodal volcanic deposits has been observed in this area; however, the rift to off-rift transition in the Iskut area is abrupt and similar rocks could be situated farther west.

BOWSER LAKE GROUP

The Terrace area lies along the southern margin of the Bowser Basin, the depocentre in which Late Jurassic to Early Cretaceous clastic strata of the Bowser Lake Group accumulated (Tipper and Richards, 1976). We recognize a variety of lithological subunits within the Bowser Lake Group, but structural complications and a lack of biostratigraphic control prevent an accurate time-stratigraphic subdivision.

The base of the Bowser Lake Group is well-defined and apparently conformable above the pyjama beds. Basal units vary from sequences of black carbonaceous siltstone to coarse sandstone and even conglomerate. This contact was the locus of strong structural disruption, and it is not clear to what degree the variability in the lowermost Bowser Lake Group reflects original facies, as opposed to different stratigraphic levels juxtaposed above a planar basal décollement.

In this area, most of the Bowser Lake Group consists of interbedded grey to black sandstone, siltstone and shale with minor limy clastic beds and dirty calcarenite. Macrofossils — bivalves, belemnites and ammonites — occur in uncommon but rich beds. Within the map area, Late Jurassic, Callovian and Oxfordian fauna have been identified (G. Woodsworth and H. Tipper, unpublished data, 1985). Coarser intervals of sandstone, grit and conglomerate are dominated by felsic volcanic sources. Rounded clasts of aphanitic, holocrystalline and porphyritic volcanic rocks, as well as sand-sized plagioclase grains, are the main reason the rocks weather pale green to white. The dominant volcanic source terrane in this area stands in strong contrast to the Bowser Lake Group in the Iskut area, and also farther upsection locally, in which northeasterly derived chert clasts from the Cache Creek Terrane are by far the most abundant. Tipper and Richards (1976) ascribe the early volcanic provenance to the uplift of the Skeena arch, a persistent east-trending structural high south of the Bowser Basin.

In one locality, east of Mt Quinlan, immature felsic volcanic breccia occurs within the Bowser Lake Group in several hundred metres of ridge exposures. They vary from jigsaw, puzzle-fit breccia to lapilli tuff comprising pebble to cobble-sized angular volcanic clasts in a clastic-volcaniclastic matrix. We interpret these as hyaloclastic deposits with local development of peperite. Volcanic deposits are known within the southern extent of the Bowser Lake Group in the Nechako area of central BC (Diakow and Levson, 1997). They represent a Late Jurassic renewal of volcanism to the south, after the mid-Jurassic demise of the Hazelton arc.

SKEENA GROUP

Clastic strata of the mid-Cretaceous Skeena Group only occur in the far western part of the Terrace map area, west of the Kitsumkalum River valley. These rocks are distinguishable from the Bowser Lake Group by the dominance of arkose as opposed to volcanic sandstone. They tend to be cream and buff-coloured, as opposed to the darker greys, greens and browns of the Bowser Lake Group. Crossbeds are common and coal is noted at several localities. In places, detrital white mica occurs within the Skeena Group sandstone.

Intrusive Units

EARLY JURASSIC KLEANZA SUITE

Intrusive bodies in the Terrace area belong to three suites of distinct age and structural setting. The oldest is the Early Jurassic Kleanza pluton, which occurs in the hangingwall of the Skeena River fault zone. This body has been dated at *ca.* 200 Ma (Gareau *et al.*, 1997a). It outcrops extensively along the Zymoetz River and Kleanza Creek in the Usk map area (Nelson *et al.*, 2006a, b). In the Terrace map area, it extends west across the Skeena River at the 'old bridge' northeast of Terrace and onto the lower slopes of Terrace Mountain (Fig 2). Overall, the Kleanza pluton shows a high degree of textural and compositional heterogeneity, with variants from gabbro to granite and fine-grained microdiorite to hornblende-plagioclase pegmatite. Its most westerly exposures, from the cliff at the base of Copper Mountain to Terrace Mountain, consist entirely of coarse-grained white to pink granite, with potassium feldspar megacrysts that range in size from a half centimetre to several centimetres. These pink megacrysts distinguish it from otherwise similar granite of the Carpenter Creek suite. The Kleanza granite does not exhibit penetrative deformation, although it is cut by discrete shear zones.

PALEOCENE KITSUMKALUM SUITE

Variably to strongly foliated, inhomogeneous granitoid occurs interlayered with Kitselas and Telkwa metavolcanic rocks between Maroon Creek on the east side of Kalum Lake, and Terrace Mountain on the northern outskirts of Terrace. This body has been dated at *ca.* 59 Ma (Gareau *et al.,* 1997a). Granite is the dominant rock type, but granodiorite and diorite are also present, the latter commonly as lenses and layers. Well-formed titanite crystals are one distinguishing feature of this suite of intrusive phases. Principally, however, the Kitsumkalum suite is identified based on the prevalence of ductile deformation fabrics within it. Unfortunately, the other plutons are cut by spaced shear zones; parts of the Kitsumkalum suite lack a homogeneous foliation. Thus, the distinction between this and the other suites is not clear everywhere. Compared to Gareau *et al*. (1997a, b), we have considerably reduced its mapped extent (Fig 2). In particular, areas assigned to the Kitsumkalum suite near the town of Terrace and around Glacier Peak are underlain by undeformed granite that we assign to the younger Carpenter Creek suite (*see* below).

Minor occurrences of foliated granite occur within the structural base of the Telkwa Formation along the Skeena River in Kitselas Canyon and near Little Oliver Creek. Their foliated, greenschist-facies volcanic hosts are considered to have been affected by the same deformational event as the Kitselas complex in the footwall of the Skeena River fault zone.

EOCENE CARPENTER CREEK SUITE

Plutons of the post-kinematic Carpenter Creek suite are large, lobate bodies that crosscut the Kitselas facies, the Paleocene Kitsumkalum suite, the Skeena River fault zone and the Telkwa Formation in its hangingwall. The Carpenter Creek pluton has been dated as *ca.* 53 Ma (Gareau *et al*., 1997a). The Carpenter Creek and Hardscrabble plutons occupy a large area between the Skeena River and Glacier Peak. They are actually two connected lobes of a single intrusion (Fig 2). A third body, the Newtown Creek pluton, outcrops in the hills north of Terrace. Like the others, it is coarse-grained, undeformed and intrudes rocks of the Kitselas complex that have been deformed in a ductile manner. Granite dominates these bodies, with lesser granodiorite; finer-grained porphyritic phases form local dike swarms.

Structure and Metamorphism

FRAMEWORK

The Terrace area is divided into three structural panels, defined by major faults along the east side of the Kitsumkalum valley and along the Skeena River (Fig 2). The Skeena River fault zone (SRFZ) is poorly exposed and largely obscured by Eocene plutons and later high-angle faults. The Usk fault (Nelson *et al.*, 2006a, b) is part of this system. The Usk fault dips gently to moderately to the east. Geological relationships across the SRFZ are suggestive of both early thrust movement and later top-to-the-east detachment. Faults along the east side of the Kitsumkalum valley are steep, with down-to-the-west normal and also dextral displacement. They postdate the gently dipping faults of the SRFZ and they cut the Eocene granite, as well as all older units.

The Kitsumkalum valley is a graben, bounded to the east by high-angle faults. It is mostly underlain by the unmetamorphosed Bowser Lake Group; Kitsumkalum Mountain west of Terrace is a small horst of Telkwa Formation. The height of land between Terrace, Kitsumkalum Lake and the Skeena River is an uplifted Paleocene metamorphic complex, the Kitselas complex, which comprises the Kitselas felsic volcanic facies of the Telkwa Formation, overlying upper Telkwa metavolcanic rocks, the Smithers Formation and pyjama beds, and the lowest part of the Bowser Lake Group near Maroon Creek. The hangingwall of the Skeena River fault zone east of the Skeena River is a single north-northeasterly dipping panel of generally unmetamorphosed Permian to Jurassic supracrustal rocks. This geological scenario was recognized by G. Woodsworth and his coworkers (Woodsworth *et al*., 1985; Gareau *et al.*, 1997a, b; G. Woodsworth, pers comm, 2005, 2006). Here we corroborate and amplify the structural history of the area, focusing on the multistage development of the Kitselas complex.

EARLY DEVELOPMENT OF THE SKEENA RIVER FAULT ZONE

Correlation of the mainly felsic volcanic strata of the Kitselas facies within the Telkwa Formation east of the Skeena River raises the question of why the Kitselas facies to the west is at a distinctly higher metamorphic grade and state of ductile deformation than its correlative Telkwa facies to the east. In our mapping, we have shown that the much of the Telkwa and Smithers strata above the Kitselas facies, in the footwall of the SRFZ, have also attained greenschist grades and are characterized by layer-parallel foliations. Thus, the metamorphic and structural history of the entire panel west of the Skeena River differs from that to the east. Gareau *et al*. (1997a, b) describe the Kitselas metamorphic complex as a Paleocene core complex, bounded above by a low-angle detachment fault along the Skeena River. This is in accord with its comparatively high metamorphic grade compared to the panel structurally above it, as well as the presence within it of deformed Paleocene granitoid rocks.

Stratigraphic relationships across the Skeena River are, however, more suggestive of thrust motion than of normal relative motion. This can be seen in a gross sense, in that stratigraphic units as old as Permian, in the hangingwall, lie above the Early Jurassic and younger rocks in the footwall west of the Skeena River (Fig 2, 3). In detail, the projection of the Skeena River fault zone toward Doreen repeats Hazelton and Bowser Lake Group rocks: upper Telkwa rhyolite east of the river near Big and Little Oliver creeks lie structurally above east-dipping Bowser Lake strata to the west. The implied stratigraphic throw is about 3500 m, taking into account local vertical motion across high-angle faults (Fig 3, 8).

The hangingwall panel east of the Skeena River dips and youngs overall to the north-northeast. If the Skeena

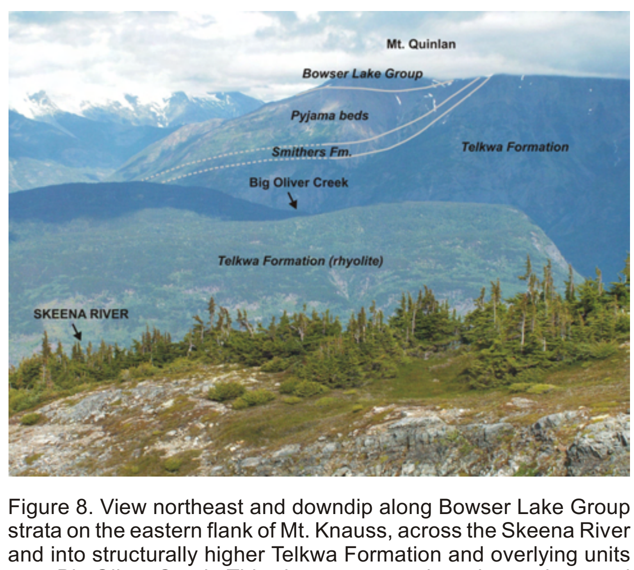

Figure 8. View northeast and downdip along Bowser Lake Group strata on the eastern flank of Mt. Knauss, across the Skeena River and into structurally higher Telkwa Formation and overlying units near Big Oliver Creek. This view corresponds to the northern end of the cross-section in Figure 3. The base of the Bowser Lake Group on Mt. Quinlan is about 3500 m structurally higher than it is west of the Skeena River. A thrust fault is inferred under the Skeena River valley (Fig 2, 3).

River fault zone is modelled as a frontal hangingwall ramp, then early thrust motion on it was probably to the north-northeast, perpendicular to the strike of the main units (Fig 2). Apparent horizontal displacement of the Smithers – pyjama bed marker is about 12 km (Fig 2).

Such a precursor thrusting event would explain the deeper crustal levels evidenced within the footwall, compared to the hangingwall of the SRFZ: rocks west of the Skeena River were buried beneath rocks to the east. The timing of this thrust imbrication is broadly constrained between Late Jurassic, the age of the affected Bowser Lake Group strata, and Paleocene, the age of the deformed granite of the core complex. In terms of regional events, Evenchick (2001) describes north-northeast shortening of the Bowser Basin in Middle to Late Cretaceous time. This is considered the most probable age for initial thrusting across the SRFZ.

LOW-ANGLE FAULTING AND RELATED FOLDING IN THE BOWSER LAKE GROUP

Compared to the Telkwa and Smithers Formations, which form a simple homoclinal package, strata of the Bowser Lake Group (BLG) are extensively imbricated along gently dipping planar faults. Structures of this type are particularly prominent around Mt Quinlan. There, the basal detachment is within the thinly bedded chert of the pyjama beds, which is, in places, repeated along with panels of the overlying BLG (Fig 2). A variety of features document the sense of motion. Folds within panels are overturned to the southwest; minor structures within fault zones show top-to-the-southwest sense of shear (220–240°) and steeply-dipping porphyritic granite dikes are consistently displaced towards the southwest (Fig 9). Farther to the west, Mihalynuk and Friedman (2005) describe top-to-the-south thrust faults within the BLG near Kalum Lake.

The sense of displacement in the BLG corresponds neither to the north-northeast thrust sense inferred for the SRFZ, nor to Paleocene-Eocene tops-to-the-east denudation of the Kitselas complex discussed below. Very strong southwest-vergent crustal compression affected the Coast Mountains west of Terrace in Late Cretaceous time (Andronicos *et al.*, 1999; Crawford *et al.*, 2000). The structures that we see in the BLG east of the Skeena River may represent the most easterly edge of this crustal-scale deformational belt. In any event, the structural history of this area on the eastern flank of the Coast Mountains has been complex and is not yet well understood or constrained in time.

Figure 9. Steeply northeast-dipping plagioclase-porphyritic dike displaced on top-to-the-southwest shears, south of Mt Quinlan.

METAMORPHISM AND STRUCTURES WITHIN THE KITSELAS COMPLEX

With the exception of Smithers sandstone near Carpenter Creek, all stratified rocks below the pyjama beds between the Skeena River and the Kitsumkalum valley are regionally metamorphosed to greenschist facies. Diagnostic minerals in the predominant felsic metavolcanic rocks are lacking, but all of the mafic units contain actinolite-epidote-chlorite±garnet assemblages. Synkinematic cordierite is present in the Smithers Formation near Kalum Lake and andalusite is seen in the lowermost Bowser Lake Group near Maroon Creek. Some of the andalusite may be of contact metamorphic origin.

Two types of synmetamorphic planar fabrics were observed in Kitselas metavolcanic rocks. In the centre of the complex, foliation is axial planar to major northeasterly, upright, open folds. Nearer to the eastern and northern margins of the complex, layering is transposed into the foliation, dipping moderately to the northeast near the Skeena River and to the northeast and northwest along its northern side from the headwaters of Hardscrabble Creek to north of Maroon Creek. Lineations plunge northeasterly. Although it is tempting to relate them to top-to-the-northeast motion during denudation of the Kitselas complex, in the course of our work we have not located many shear-sense indicators in this area; it is equally possible that the lineations developed during earlier top-to-the-northeast thrust motion on the SRFZ.

The metamorphosed Telkwa and Smithers rocks in highway outcrops between Maroon Creek and the northern end of Kalum Lake show northwest-vergent recumbent folds (Fig 10a), and top-to-the-northwest shears are developed in the northern edge of the Kitsumkalum granite where it intrudes the Telkwa Formation near Maroon Creek (Fig 10b).

These structures may be related to denudation of the northern Kitselas complex on a separate, northwesterly-vergent fault located within the Bowser Lake Group. Low-angle detachments are apparent within it on the south face of Maroon Mountain and G. Woodsworth (pers comm, 2005) has located a possible detachment fault near the summit of this east-trending ridge. Such a fault would explain the rapid decline in metamorphic grade from the glossy, cordierite-bearing chlorite-sericite schist in the Smithers Formation to low-grade Bowser Lake Group strata north of Kalum Lake. On Figure 2, we also have located an inferred, top-to-the-north detachment fault from north of Maroon Mountain, through the lower Fiddler Creek drainage and across the Skeena River north of Big Oliver Creek, to account for discontinuities in structural trends as well as the decrease in grade.

LATE FAULTS

North to north-northwest-striking, steeply dipping to vertical faults occur throughout the area. The most prominent are those that define the western margin of the Kitselas complex. Fault strands exposed along the highway near Kalum Lake are thin zones of retrograde chlorite with downdip, or in some cases gently plunging, lineations. Deflection of foliations and shear bands indicate down-to-the-west motion (Fig 11). Some slickensides reflect a dextral component of motion. Prominent linears in the hills north of Terrace probably correspond to subsidiary faults belonging to this set.

There are at least three prominent north-northwest faults that cut the Kitselas complex and the Hardscrabble pluton. The displacement of fold axial traces on two of these indicates dextral displacements on the order of 500 m to 1 km. The east-side-down Tumbling Creek fault extends north from the Usk map area (Nelson *et al*., 2006a, b) into the hills near Carpenter Creek.

SUMMARY OF STRUCTURAL HISTORY

The Cretaceous to Eocene structural history of the Terrace area is complex, reflecting the major tectonic events that affected all of northwestern BC. The earliest event that we infer was the north-northeasterly imbrication of the Stikinian stratigraphic section, from Permian through to Late Jurassic, within the westerly hinterland of the Bowser fold and thrust belt. This was the earliest expression of the Skeena River fault zone. Although relative age constraints are not available, we tentatively relate south and southwesterly-vergent thrusting and folding in the Bowser Lake Group to the southwest-vergent thick-skinned deformation near Prince Rupert, described by Crawford *et al.* (2000). This event was complete by Paleocene time and built the tectonic welt that would collapse during core complex formation in the Eocene (Rusmore *et al*., 2005). The Shames River shear zone and Shames River fault west of Terrace (Heah, 1991) represent easterly directed tectonic denudation at lower crustal levels during this time, while top-to-the-east detachment faulting on the SRFZ and top-to-the-northwest shears northeast of Kitsumkalum Lake exhumed the Kitselas complex from mid to upper crustal levels. Near the end of this event, steeper faults created the Kitsumkalum graben and displaced the SRFZ.

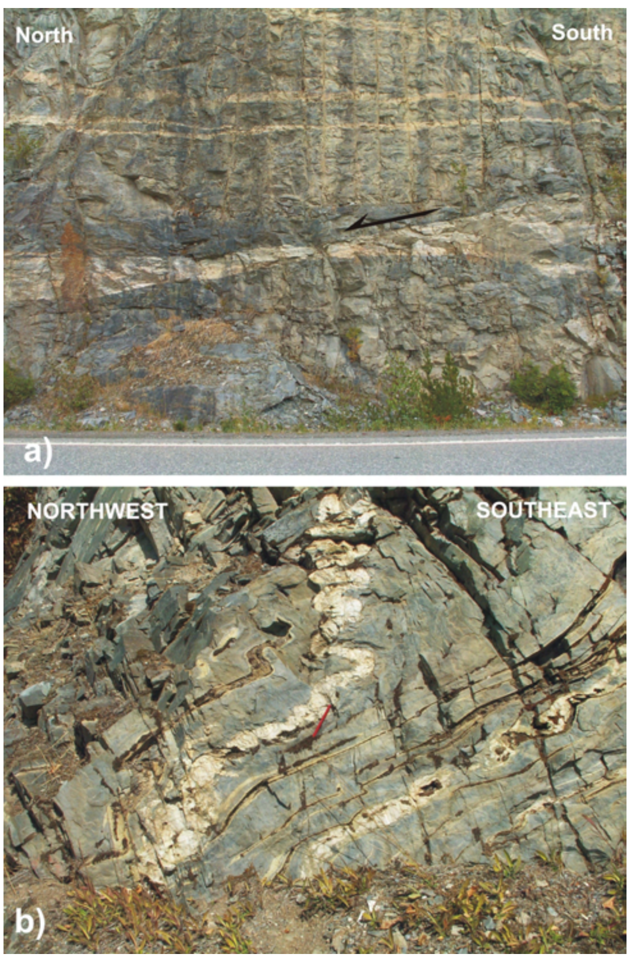

Figure 10. a) Northwest-vergent recumbent folds in metamorphosed Smithers Formation strata on the Nisga'a Highway near the north end of Kitsumkalum Lake. Minor fold axes trend northeasterly; b) gently-dipping shear band displaces a metre-thick apophysis of the Paleocene Kitsumkalum intrusion in a down-to-the-northwest sense; exposure north of Maroon Creek on the Nisga'a Highway.

MINERALIZATION

Compared to the Usk map area, with its over 80 MINFILE occurrences, the southern Doreen and eastern Terrace map areas contain less-known mineral prospects. Our field study suggests that this may be in part due to a less thorough investigation, and we would like to highlight two particular areas that offer significant exploration possibilities. The first prospective area is on the northern slopes of Mt Sir Robert, where 2006 regional mapping has located a number of new copper showings in the upper part of the Telkwa Formation (Fig 2; Table 1, #27–#33; *see also* Nelson and Kennedy, in prep). This area displays a spectacular exposure of glacially scoured brick-red Telkwa volcanic rocks, cut by at least a dozen large (2–3 m wide) dikes, which are generally oriented in a linear east-west direction. The dikes range from felsic to intermediate in composition, suggesting multiple intrusive events.

These copper showings are numerous (Nelson and Kennedy, in prep) and extend over several kilometres to the northwest of the mineralization described by Carter (1996) on the northeastern side of the mountain, where similar copper mineralization was also encountered in 2006 (Table 1, #25, 26). Most of them are quartz-carbonate veins that contain malachite, chalcopyrite, azurite, pyrite and tetrahedrite (Fig 12). Although the individual veins are only a few centimetres thick, in places mineralization can be followed for tens of metres. Copper values in grab sam-

Figure 11. Highway exposure, east of Kitsumkalum Lake, of down-to-the-west shear bands along the western margin of the Kitsumkalum intrusion.

TABLE 1. GEOCHEMICAL DATA FROM PROSPECTING SAMPLES COLLECTED IN 2006; ABBREVIATIONS: ARG, ARGILLITE; BO, BIOTITE; CPY, CHALCOPYRITE; DISSEM, DISSEMINATED; FRACS, FRACTURES; GN, GARNET; MOLY, MOLYBDENITE; MT, MAGNETITE; OC, OUTCROP; PY, PYRITE; QTZ, QUARTZ; RHY, RHYOLITE; SPEC, SPECULAR; TETR, TETRAHEDRITE.

#	Station number	UTM Easting	UTM Northing	MINFILE	Description	Mo	Cu	Pb	Zn	Ag	Mn	Fe	As	Au	Cd	Sb	Bi	W	Hg	Se	Te
					Element:	Mo	Cu	Pb	Zn	Ag	Mn	Fe	As	Au	Cd	Sb	Bi	W	Hg	Se	Te
					Units:	(ppm)	(ppm)	(ppm)	(ppm)	(ppb)	(ppm)	(%)	(ppm)	(ppb)	(ppm)	(ppm)	(ppm)	(ppm)	(ppb)	(ppm)	(ppm)
					Method:	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS
					Lab:	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM
					Detection limit:	0.01	0.01	0.01	0.1	2	1	0.01	0.1	0.1	0.01	0.02	0.02	0.2	5	0.1	0.02
1	06JA01-02	528707	6041963		rusty shear with minor sulphides, malachite stain	6.88	143.18	12.89	145.7	310	943	5.59	0.5	5.7	0.24	0.09	0.23	3.6	<5	0.2	0.2
2	06JN04-04	516364	6047583		qtz veins with spotty cpy, tetr, py, gn, bo	3.03	3848.72	230.56	770	57915	43	1.57	3.2	207	20.49	69.35	3.69	0.4	46	1.2	0.56
3	06JN06-02	539900	6076158	Brentford 103I 188	ore stockpile sulphide rich qtz vein adit Fiddler Cr	0.55	2240.4	>10000	>10000	>100000	96	4.7	>10000	841.8	73.18	75.61	13.44	<.1	1623	12.5	0.05
4	06JN07-01	547238	6072981		py-mt bearing deformed felsic intrusive	3.81	12.3	12.45	12.4	228	113	2.75	4.2	0.9	0.07	0.47	0.32	0.6	<5	2.1	0.13
5	06JN07-02	547183	6073053		py-mt bearing deformed felsic intrusive	0.46	11.45	78.76	56.8	633	131	2.98	16.8	1.2	0.19	0.38	0.54	3.2	7	2	0.17
6	06JN07-03	548111	6073576		py-mt bearing deformed felsic intrusive	0.23	27.18	5.84	9.9	108	170	1.45	0.2	0.2	0.05	0.14	0.16	0.1	<5	<.1	0.02
7	06JN14-03	551628	6069008		dissem pyrite parallel to bedding in grey tuff	0.88	9.62	12.19	27.5	211	167	2	7.7	0.6	0.09	0.26	0.46	<.1	<5	0.5	0.27
8	06JN14-05	551638	6069373		dissem pyrite parallel to bedding in grey tuff	5.38	1978.96	5.21	135.7	3791	331	7.2	5.5	28.6	0.36	0.54	1.52	<.1	45	10.9	0.58
9	06JN14-08	551414	6069295		dissem pyrite parallel to bedding in grey tuff	1.2	222.45	3.96	55.9	895	566	5.04	18.3	14.6	0.08	0.33	1.66	0.9	5	3.9	0.6
10	06JN15-05	550609	6069775		zones of strong silica and py along foliation	1.14	11.2	10.2	59.9	452	670	5.34	28.3	1.7	0.06	0.31	1.06	<.1	16	1.6	1.36
11	06JN19-04	556428	6077474		pyritic pyjamas	8.73	33.52	11.87	65.8	181	223	4.5	31.6	<.2	0.15	3.02	0.54	1.6	60	3	0.19
12	06JN21-01	555167	6078438		pyrite in blk arg	2.12	20.21	7.45	50.9	106	232	1.77	10.8	<.2	0.25	1	0.08	1.1	30	1.4	0.03
13	06JN24-06	552309	6076538		malachite and chalcocite - narrow zones in limestone	2.38	>10000	3.07	83.2	>100000	605	4.28	<.1	362.7	0.13	0.03	0.06	<.1	55	1.2	0.15
14	06JN26-05	551492	6078782		pyritic pyjamas	4.06	56.97	8.57	70.3	125	604	4.21	25	<.2	0.12	1.05	0.12	0.2	5	2	0.04
15	06JN31-04a	539692	6071524	Womo 103I 122	cpy-py 2 m trench grab	25.46	>10000	24	90.8	55110	222	3.93	23.7	878.5	3.95	2.52	62.72	0.6	35	19.6	30.7
16	06JN31-04b	539692	6071524	Womo 103I 122	1 m qtz vein no visible sulphides	4.98	101.7	6.35	9.6	446	192	0.59	2.2	8.4	0.04	9.2	0.55	0.1	22	0.2	0.14
17	06JN32-06	540903	6070637	Womo 103I 122	moly-cpy in qz vns, 0.5% of outcrop	424.83	614.57	16.83	36.3	5899	203	2.2	9.8	5.2	<.01	0.41	1.06	35.2	<5	2.3	0.78
18	06JN32-08	540500	6070893	Womo 103I 122	moly-cpy in qtz veins, 5% of local float	451.35	996.88	14.81	14.1	3690	74	0.84	2.2	12.2	0.13	3.8	2.61	0.3	<5	2	0.43
19	06JN35-06	528571	6067239		rusty pyritic zone large hill slope	1.59	34.48	4.87	42.2	116	245	2.89	1	0.3	0.11	0.13	0.14	<.1	<5	0.2	0.02
20	06JN39-04	539692	6071524		silica-pyrite alteration at edge of large gossan, head of Hankin Cr.	7.64	29.28	6.2	6.8	279	32	2	14.4	1.7	<.01	0.44	0.41	0.1	<5	0.2	0.25
21	06RK03-03	515928	6059562		visible pyrite, sericite alteration	6.13	7.32	40.05	8.2	814	93	0.89	0.6	3.6	0.05	0.3	1.75	<.1	<5	0.6	0.29
22	06RK14-02	544076	6076819		Cu-stained granite + py, cpy, mt 2 m oc?	0.9	1172.72	1.9	89.5	1031	699	2.16	<.1	1.8	0.14	0.05	5.4	<.1	<5	0.3	2.28

TABLE 1 (CONTINUED)

#	Station number	UTM Easting	UTM Northing	MINFILE	Description	Mo	Cu	Pb	Zn	Ag	Mn	Fe	As	Au	Cd	Sb	Bi	W	Hg	Se	Te
					Element:	Mo	Cu	Pb	Zn	Ag	Mn	Fe	As	Au	Cd	Sb	Bi	W	Hg	Se	Te
					Units:	(ppm)	(ppm)	(ppm)	(ppm)	(ppb)	(ppm)	(%)	(ppm)	(ppb)	(ppm)	(ppm)	(ppm)	(ppm)	(ppb)	(ppm)	(ppm)
					Method:	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS	ARMS
					Lab:	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM	ACM
					Detection limit:	0.01	0.01	0.01	0.1	2	1	0.01	0.1	0.1	0.01	0.02	0.02	0.2	5	0.1	0.02
23	06RK15-02a	517239	6067596		1 m qz vein with mal, py, cpy part of larger set	10.81	725.47	1.93	53.6	1963	542	2.12	<.1	4.5	0.16	0.04	0.5	8	<5	0.2	0.08
24	06RK15-02b	517239	6067596		another vein in set could continue 20 m under cover	9.52	952.28	3.02	90.5	1329	610	2.28	<.1	5	0.59	0.09	0.47	0.1	<5	0.2	0.19
25	06RK18-02	559991	6070420	Rob (no number)	cpy, azurite, malachite from 2 veins	0.4	>10000	114.38	171.9	>100000	424	3.68	24.6	868.4	4.14	333.45	17.34	0.3	1295	63	0.52
26	06RK19-05	561547	6068373	Rob (no number)	ROB vein (AR 24544)	0.85	3509.05	9.55	40.1	>100000	65	0.65	21.6	1.1	0.38	25.29	0.08	<.1	671	0.2	0.02
27	06RK21-02	557786	6073276	Borden Gl. (new)	Cu staining in fracs and spec hematite	0.28	1393.31	1.52	76.9	3290	1513	1.74	<.1	1	0.15	0.4	0.05	<.1	12	0.1	0.02
28	06RK21-06a	558253	6074260	Borden Gl. (new)	A: vein of massive sulphides	6.89	352.3	11.33	19.3	2086	292	31.46	>10000	37	0.45	31.94	0.05	<.1	26802	6.2	0.05
29	06RK21-06b	558253	6074260	Borden Gl. (new)	B: dissem through rhy	248.68	47.94	5.24	46.9	455	904	5.96	2552.6	0.7	0.28	10.31	0.05	0.2	4368	0.3	<.02
30	06RK22-01	556792	6073665	Borden Gl. (new)	sulphides in veinlets and dissem	49.88	394.83	814.9	70.7	20013	746	1.83	19.2	121.8	1.13	0.4	6.46	<.1	58	1.4	0.41
31	06RK22-03	556574	6073928	Borden Gl. (new)	Cu staining in 'blue' alteration zone	0.89	4525.88	3	70	12966	1386	1.72	4.3	222.6	0.65	0.16	0.07	<.1	30	0.2	0.5
32	06RK22-09	556173	6073890	Borden Gl. (new)	very heavy sample of malachite tetrahedrite	0.18	>10000	11.03	57.4	>100000	1174	1.22	0.8	166.5	20.01	0.18	0.48	<.1	272	3.6	0.2
33	06RK23-01	556854	6073358	Borden Gl. (new)	dissem sulphides and malachite in brecciated vein	5.21	5257.86	10.35	6.2	4375	334	0.74	6.3	21.1	36.62	0.62	0.47	<.1	114	1	0.81
34	06RK24-03	558439	6073261	Borden Gl. (new)	cpy, malachite, bornite in veins	18.82	>10000	676.32	538.7	>100000	50	5.24	68.1	65	10.49	76.59	23.21	<.1	1660	1.9	0.51
35	06RK30-01a	538545	6069759		A; from GPS location	5.4	59.05	217.02	25.4	35312	19	5.12	3.4	278.2	1.78	0.37	66.08	0.2	15	4.1	5.73
36	06RK30-01b	538545	6069759		vein with cpy-galena	167.86	831.44	9976.23	44.3	28219	22	0.82	0.4	1258.7	2.32	10.88	15.39	76.3	29	5	0.98
37	06RK31-04	538444	6070359	Gold Dome 103I 047	from adit	3.51	17.43	57.55	17.3	636	335	0.69	2.6	380	1.75	0.61	1.25	>100	9	0.1	0.14
38	06RK31-07a	538139	6069997	Gold Dome 103I 047	float sample galena, cpy in quartz vein	78.66	2276.77	2195.22	266.9	60680	185	1.04	2.5	663.7	15.74	62.15	43.52	1.5	38	4.9	0.8
39	06RK31-07b	538139	6069997	Gold Dome 103I 047	float sample galena, cpy in quartz vein	8.38	36.02	>10000	>10000	>100000	39	2.63	0.1	8084.2	>2000	126.89	20.79	11.8	9439	7.5	7.04
40	06RK31-08	538243	6069974	Gold Dome 103I 047	float sample	59.02	4815.6	>10000	569.3	47171	23	1.35	0.4	1117.9	35.56	25.45	22.08	>100	128	6.5	1.13
41	06RK31-09	538345	6069780	Gold Dome 103I 047	qtz vein in creek, shows cpy, malachite, and py	29.77	7895.49	2536.26	851.1	28728	585	2.42	0.9	4558.7	32.39	3.84	8.11	44.1	123	1.8	0.46
42	06RK32-01	538421	6069573	Gold Dome 103I 047	vuggy qtz vein in granite with galena	215.07	29.05	4914.19	11.9	53877	30	1.02	0.1	9253	0.67	1.05	84.19	>100	23	5.6	2.13
43	06RK32-02	538386	6069663	Gold Dome 103I 047	from felsic py bearing dike	1.61	33.57	63.32	73.6	281	555	1.74	0.4	6	2.34	0.24	0.22	1.2	<5	<.1	<.02
44	06RK34-04	526184	6061166		qtz vein	4.66	32.98	28.47	49.3	414	408	3.78	0.9	11.5	0.15	0.1	1.27	2.3	7	1.2	0.22
45	06RK36-05	530445	6056174		mix of rusty qtz vein and rusty country rock from gossan	16.15	12.55	86.41	26.1	1205	47	1.34	31.7	<.2	1.9	0.32	0.44	0.3	5	2.2	1.67

ples range up to 5300 ppm (Table 1, #33), and Ag to >10 000 ppb (Table 1, #25, 26, 32). One sample from the Rob claims area contains 868 ppb Au (Table 1, #25). Malachite staining and disseminated chalcopyrite also occur in porphyritic dikes, with no apparent association with local veining. Mineralized veins are associated with minor brecciation and bluish (chlorite?) alteration in the surrounding Telkwa volcanic rocks. Two series of events are recognized to have facilitated the movement of mineralizing fluids. The first is the occurrence of dikes and breccia-forming vein systems. The intrusions both hosted the mineralization and provided heat and fluids to mobilize it into the country rocks. The second episode of mineralization occurred after the emplacement of the dikes and much of the veining in this area; it is expressed as fracture-hosted copper sulphide minerals associated with north-south dextral faulting. Mineralization of the second type is found in narrow valleys where the Telkwa is strongly altered to yellow or orange clay. These faults were never found to be more than 3 m wide. The concentration of mineralization decreases with distance from the individual fault planes. Where late fractures occur in dikes, there is an increase in mineralization. This may suggest that the highest concentration of mineralization occurs where intrusion and fault-related fluids intersect. The steep north-south faults on Mt Sir Robert are assumed to be related to the regional late faulting.

The second target of interest is a mineralized system on the southern slopes of Mt Knauss, north of Carpenter Creek. It is centred by the Womo Mo-porphyry showings (MINFILE 103I 122). This area was mapped and sampled in 1966 (Murphy and Richardson, 1966) and was the subject of a limited geochemical sampling program in 1981 (Livingston, 1980; Livingston and Carter, 1981). The recent increase in molybdenum prices provides an incentive to revisit this occurrence. In our brief traverses across it, we encountered a classic porphyry system located at the margin of the Carpenter Creek pluton. There is evidence of local shearing that involves late porphyritic phases of the granite, as well as the country rocks of the Bowser Lake Group. Conceivably, this structure could extend farther north to the area around the Doreen Mine and south to the high-grade veins at Paddy Mac and Gold Dome: they would represent the peripheral Au–Ag–base metal enrichments to the main porphyry system. In the core of the system along Rosette Creek (*see* Murphy and Richardson, 1966), we encountered a zone 200 by 1100 m of intense clay-sericite alteration with chalcopyrite and molybdenite in quartz vein stockworks (Fig 13a, b, c). Two vein grab samples from rubble in the stockwork zone contain 600 to

Figure 12. Malachite-stained, copper-rich quartz-carbonate vein north of Borden Glacier, one of many showings in this recently deglaciated area.

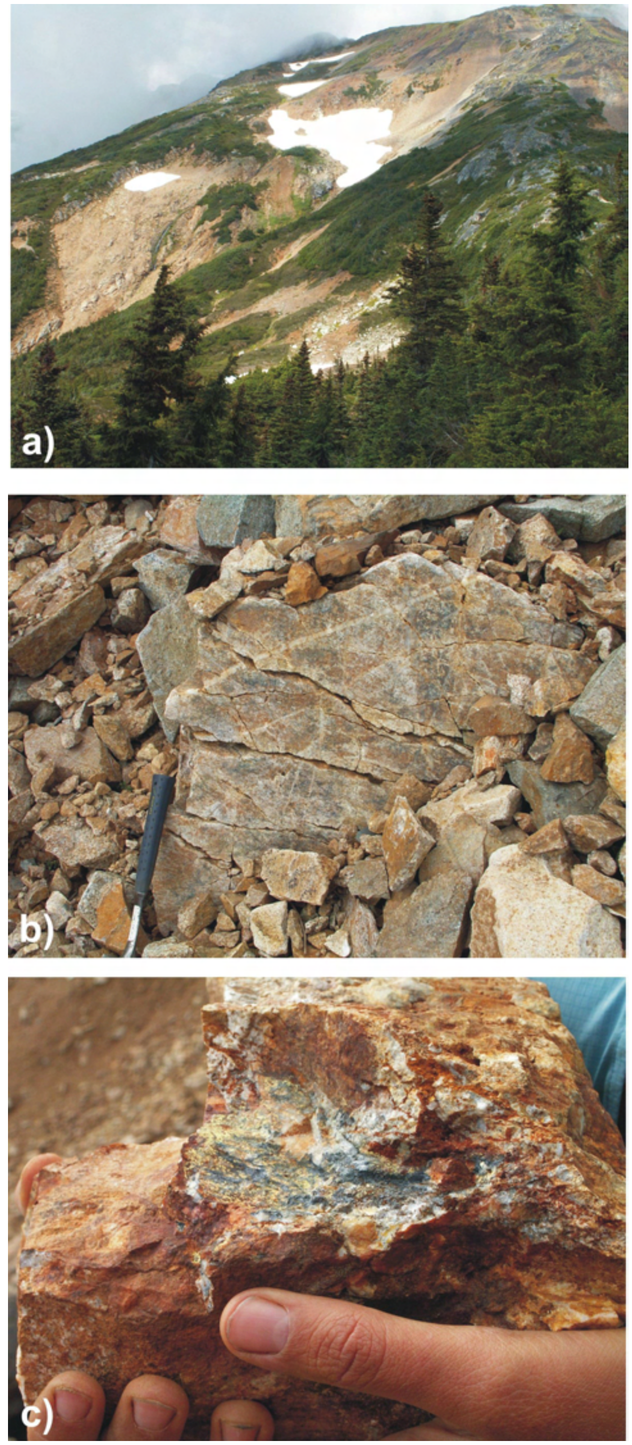

Figure 13. a) View of the Womo porphyry system along Rosette Creek, with pyritic hornfels in the foreground; b) example of stockwork quartz veining; c) molybdenite-chalcopyrite-bearing quartz vein.

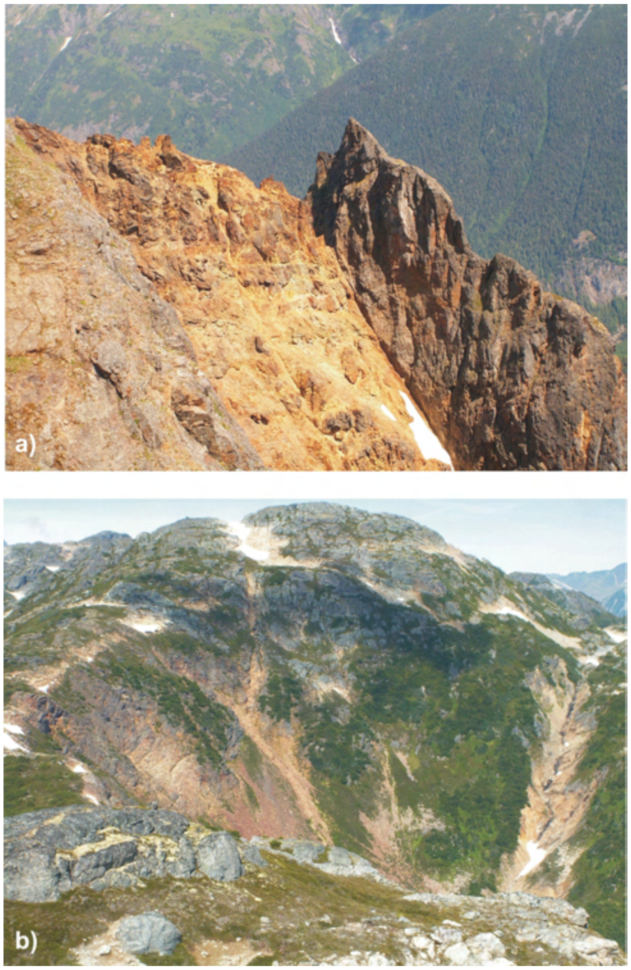

Figure 14. a) Strongly pyritic fault zone between Legate and Little Oliver creeks; b) large gossan in saddle between Hankin and Lean-to creeks.

1000 ppm Cu and 400 to 500 ppm Mo (Table 1, #17, 18). This system is open downslope in the steep, timbered gullies to the south. The core of the altered and mineralized system is partially surrounded to the northeast by a strong pyritic halo in the Bowser Lake clastic strata that measures 300 by 2000 m. This property is currently held by Knauss Creek Mines, who have been focusing their exploration efforts on the veins in Knauss Creek.

In addition to these groups of showings, there are some large pyritic gossans in the area that contrast with mineralization styles in the Usk map area. One is on the low ridge immediately north of Legate Creek. It is associated with steep north-striking faults (Fig 14a). Large patches of felsic volcanic rock are replaced by silica with up to 15% pyrite. Some of these were prospected, but others on cliffs and below the treeline remain unexamined. Two of four samples in this area (Table 1, #7–#10) contain anomalous Cu (to 1980 ppm) and Ag (to 3791 ppb). There is also a large, prominent, rusty pyritic gossan that lies across the height of land between Hankin and Lean-to creeks (Fig 14b). There is no record of assessment work on it; it remains an intriguing and unexplained possibility. Our single sample of it (Table 1, #20) is geochemically undistinguished; however, it in no way represents the potential of this large altered area.

CONCLUSIONS

The geology, structure and mineralization described for the Terrace area result from the conjunction of two fundamental provinces within the BC Cordillera. Stratigraphically, and in terms of its older (Early Jurassic) plutons, the area is part of the Stikine terrane. Structurally, it shows a strong influence of the eastern Coast Belt orogen. The Eocene, molybdenite-bearing plutons are related both to the eastern Coast Belt and to similar plutons of the Skeena arch.

In the 2006 mapping, we have traced out a continuous belt of uppermost Hazelton Group rocks, Smithers Formation and pyjama beds, for over 30 km of strike length. The pyjama beds are at least in part, time equivalent with the Eskay Rift facies in northwestern BC. We have also refined the definition and history of the Kitselas complex, an uplifted belt of metamorphosed Early Jurassic and younger strata that outcrops between the Skeena and Kitsumkalum rivers, north of Terrace. We propose that it was shaped by Cretaceous thrust imbrication followed by Paleocene to Eocene exhumation.

New copper mineralization discovered north of Mt Sir Robert marks a northern continuation of a copper-rich belt in the Telkwa Formation that extends north from Treasure Mountain through the Legate Creek area (*see* Nelson *et al*., 2006 a, b). A significant zone of porphyry-style molybdenite and chalcopyrite mineralization on the Womo claims is part of a zone of molybdenite occurrences associated with the eastern side of the Carpenter Creek pluton. It includes the Shan property (MINFILE 103I 114), which was being drill tested by BCM Resources at time of writing (P. Wojdak, pers comm, 2006).

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REFERENCES

Anderson, R.G. and Thorkelsen, D.J. (1990): Mesozoic stratigraphy and setting for some mineral deposits in Iskut River map area, northwestern British Columbia; *in* Current Research, *Geological Survey of Canada*, Paper 90-1F, pages 131–139.

Andronicos, C.L., Hollister, L.S., Davidson, C. and Chardon, D. (1999): Kinematics and tectonic significance of transpressive structures in the Coast Plutonic Complex, British Columbia; *Journal of Structural Geology*, Volume 21, pages 229–243.

Carter, N.C. (1996): Geochemical report on the Rob mineral claims, for R.T. Heard; *BC Ministry of Energy, Mines and Petroleum Resources*, AR24544, 14 pages.

Crawford, M.L., Crawford, W.A. and Gehrels., G.E. (2000): Terrane assembly and structural relationships in the eastern Prince Rupert quadrangle, British Columbia; *in* Tectonics of the Coast Mountains, southeastern Alaska and British Columbia, Stowell, H.H. and McClelland, W.C., Editors, *Geological Society of America,* Special Paper 343, pages 1–22.

Evenchick, C.A. (2001): Northeast-trending folds in the western Skeena fold belt, northern Canadian Cordillera: a record of Early Cretaceous sinistral plate convergence; *Journal of Structural Geology*, Volume 23, pages 1123–1140.

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; *in* Current Research, *Geological Survey of Canada*, Paper 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; in Current Research, *Geological Survey of Canada*, Paper 1997-A/B, pages 47–55.

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; MSc thesis, *The University of British Columbia*, 155 pages.

Livingston, K.W. (1980): Prospecting report on geology, Womo claims, for Prism Resources Ltd.; *BC Ministry of Energy, Mines and Petroleum Resources,* AR8374, 8 pages.

Livingston, K.W. and Carter, N.C. (1981): Geochemical Report on Womo 1 and 2, for JMT Services Ltd.; *BC Ministry of Energy, Mines and Petroleum Resources,* AR9524, 8 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 (2006): MINFILE BC mineral deposits database; *BC Ministry of Energy, Mines and Petroleum Resources*, URL <http://www.em.gov.bc.ca/Mining/Geolsurv/Minfile/> [December 2006].

Murphy, D.J. and Richardson, P.W. (1966): Knauss Mountain claims; Dug group 54°N, 128ºE, for Southwest Potash Corporation; *BC Ministry of Energy, Mines and Petroleum Resources,* AR798, 21 pages.

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

Nelson, J.L., Barresi, T., Knight, E. and Boudreau, N. (2006b): Geology and mineral potential of the Usk map area (103I/09) near Terrace, British Columbia; *BC Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 2005, Paper 2006-1, pages 117–134.

Nelson. J.L. and Kennedy, R. (in prep): Geology of the Doreen south half (103I/16S) and Terrace east half (103I/10E) map areas, near Terrace, British Columbia; *BC Ministry of Energy, Mines and Petroleum Resources,* Open File, 1:50 000.

Diakow, L.J. and Levson, V.M. (1997): Bedrock and surficial geology of the southern Nechako Plateau, central British Columbia (NTS 93F/2, 3, 6, 7): *BC Ministry of Energy, Mines and Petroleum Resources*, Geoscience Map 1997-2, 1:100 000 scale.

Rusmore, M.E., Woodsworth, G.J. and Gehrels, G.E. (2005): Two-stage exhumation of midcrustal arc rocks, Coast Mountains, British Columbia; *Tectonics*, Volume 24, TC5013, doi:10.1029/2004TC001750.

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.

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