Glenlyon project: Preliminary stratigraphy and structure of Yukon-Tanana Terrane, Little Kalzas Lake area, central Yukon (105L/13)

Maurice Colpron
Yukon Geology Program

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ABSTRACT

Yukon-Tanana Terrane in Little Kalzas Lake area consists of a lower quartzite package and an upper metavolcanic package. The lower quartzite package includes a discontinuous metavolcaniclastic and mafic metavolcanic unit. The upper metavolcanic package consists predominantly of intermediate to felsic metavolcanic rocks in the northern part of the map area. These rocks pass southward into a clastic-dominated metavolcanic assemblage. A conspicuous crinoidal marble occurs in the middle of the upper metavolcanic package and can be traced between the northern and southern domains.

The layered metamorphic rocks are intruded by the multi-phase Little Kalzas orthogneiss complex in the northeastern part of the map area along the southwestern side of Tintina Trench. The Little Kalzas orthogneiss complex, of uncertain age, comprises granodioritic to granitic gneiss and contains abundant xenoliths of country rock. Younger (Jurassic?), post-kinematic quartz monzonite (in the north) to quartz-diorite (in the south) plutons also intrude the area. The youngest intrusive rocks are small plugs of Tertiary quartz-feldspar porphyry.

A pervasive transposition foliation and mineral lineation are developed throughout the area, except in local low-strain domains where primary textures are preserved. The transposition foliation is axial-planar to tight south southwest-vergent folds whose axial surfaces become progressively upright to south southwest-dipping toward the northeast. These structures are deformed by younger crenulation cleavages and associated open folds.

RÉSUMÉ

Dans la région du lac Little Kalzas, le terrane de Yukon-Tanana est formé d'un assemblage inférieur de quartzite et d'un assemblage supérieur de roches métavolcaniques. L'assemblage inférieur de quartzite contient une unité métavolcanoclastique discontinue qui inclue des roches métavolcaniques mafiques. Dans la partie septentrionale de la région, l'assemblage supérieur est composé essentiellement de roches métavolcaniques intermédiaires à felsiques qui passent vers le sud à un assemblage à dominante métavolcanoclastique. Du marbre à crinoïdes est visible dans la partie médiane de l'assemblage métavolcanique supérieur; on peut le retracer entre les domaines septentrionaux et méridionaux.

Les roches métamorphiques stratifiées sont pénétrées par le complexe d'orthogneiss polyphasé de Little Kalzas qui s'est mis en place dans le nord-est de la région cartographiée, le long de la bordure sud-ouest du sillon de Tintina. Le complexe d'orthogneiss de Little Kalzas, d'âge incertain, contient des gneiss granodioritiques à granitiques qui renferment d'abondants xénolites de la roche encaissante. Des plutons postorogéniques, d'âge plus récent (Jurassique?), allant des monzonites quartzifères (dans le nord) à des diorites quartzifères (dans le sud) sont aussi présents dans la région. Les roches intrusives les plus récentes sont de petits dômes de porphyres à quartz et feldspaths d'âge Cénozoïque.

À l'exception de domaines locaux légèrement déformés où les textures primaires ont été préservées, la région est caractérisée par une schistosité pénétrative de transposition et une linéation minérale. La schistosité de transposition est de plan axial à des plis fermés à vergence sud-sud-ouest, lesquels, vers le nord-est, deviennent progressivement droits, puis s'inclinent vers le nord-nord-est. Ces structures sont déformées par des clivages de crénulation qui sont de plan axial à des plis ouverts.

INTRODUCTION

This report presents preliminary results from 1:50 000-scale bedrock mapping of Little Kalzas Lake area (105L/13) initiated during the summer of 1998 (Colpron, 1998). Little Kalzas Lake area occupies the northwest corner of the Glenlyon map area, which was previously mapped at the scale of 1:253 440 by Campbell (1967). Campbell's work identified a 30-50 km-wide, northwest-striking belt of metasedimentary, metavolcanic and metaplutonic rocks southwest of Tintina Trench in the centre of Glenlyon map area which has been correlated with Yukon-Tanana Terrane (Fig. 1; Tempelman-Kluit, 1979; Coney et al., 1980; Wheeler et al., 1991). Restoration of 450 km of dextral displacement along Tintina Fault juxtaposes this belt of rocks with Yukon-Tanana Terrane rocks in the Finlayson Lake area in which numerous volcanic-hosted massive sulphide deposits and occurrences have been recently found (e.g., Kudz Ze Kayah, Wolverine; Hunt, 1997). These new discoveries have increased the need for a better understanding of the stratigraphy and tectonic evolution of the terrane as a whole but in particular of nearby areas about which little is known, such as Little Kalzas Lake area.

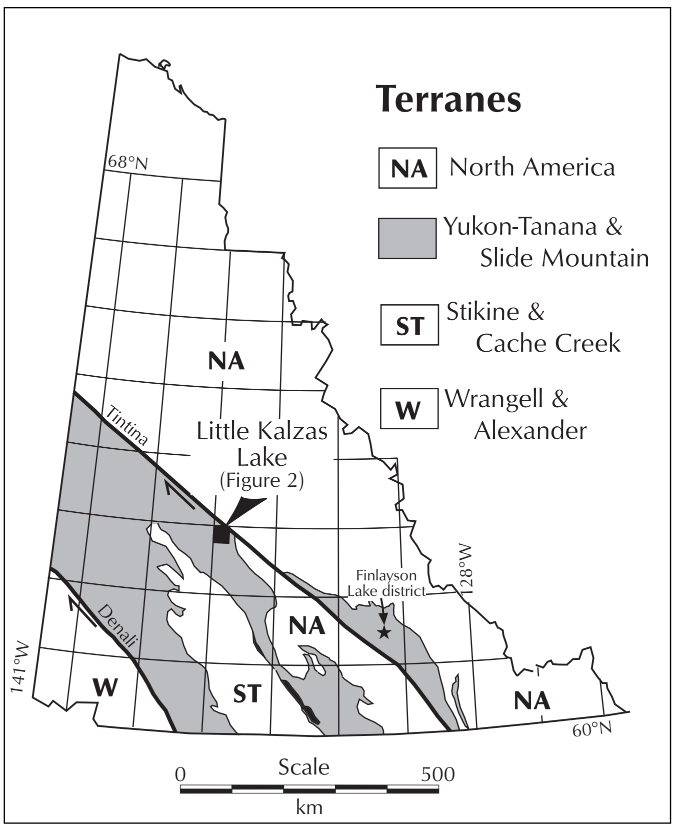

Figure 1. *Location of the Little Kalzas Lake area with respect to distribution of Yukon-Tanana Terrane in the Yukon and to syngenetic sulphide deposits of the Finlayson Lake district.*

STRATIGRAPHY

The regional stratigraphy of Yukon-Tanana Terrane in Little Kalzas Lake area comprises a lower quartzite package (Unit 1) and an upper metavolcanic package (Units 2 and 4) containing a conspicuous marble marker (Unit 3). Up to nine mappable units were identified in alpine exposures along ridges north of Macmillan River. However, only a four-fold subdivision of the layered rocks could be traced into the heavily forested areas which cover much of the Little Kalzas Lake area.

Metasedimentary and metavolcanic rocks in the area generally are pervasively deformed (strongly foliated and lineated) and metamorphosed to greenschist facies. Although pristine primary textures are preserved sporadically, the facing direction of the stratigraphic sequence could not be determined with certainty. Therefore, stratigraphic units are described below according to their structural position (assuming an upright stratigraphic sequence prior to dominant regional deformation). This stratigraphic sequence is provisional and most likely will be revised after further field, biostratigraphic and geochronologic studies are completed.

UNIT 1 (QUARTZITE UNIT)

The lowest stratigraphic unit in Little Kalzas Lake area consists predominantly of massive to well-bedded quartzite (Figs. 2 and 3). The quartzite commonly displays white to medium grey wispy banding. It is progressively more micaceous up-section, where it is commonly intercalated with dark grey phyllite. North of Macmillan River, primary layering in the quartzite is generally obliterated by the dominant foliation. On Pelmac Ridge, the quartzite typically occurs in beds 10 to 40 cm thick (Fig. 2).

The quartzite unit includes a middle metavolcaniclastic unit (Unit 1v) around Dillweed Plateau (informal name; see Fig. 4). The metavolcaniclastic unit consists primarily of light green chloritic phyllite intercalated with light green quartzite and feldspathic grit. Minor greenstone and felsic schist occur within the metavolcaniclastic unit along the east flank of Dillweed Plateau. Brown weathering dolomitic lenses are common within the chloritic phyllite and greenstone. Along the southern margin of Dillweed Plateau, phyllite of the metavolcaniclastic unit is locally intercalated with coarse-grained metadiorite of the Dillweed orthogneiss (unit Mgd, Fig. 4). The metavolcaniclastic unit passes eastwardly into a mixture of dark grey to dark green phyllite and thin horizons (< 1 m) of dark grey quartz grit which are indistinguishable from dark grey quartzite and phyllite of Unit 1 to the southeast.

South of Pelmac Ridge, the quartzite is inferred to pass laterally into coarse-grained dolomitic grit and beige weathering, medium to dark grey quartz-muscovite-dolomite schist[1] (Unit 1gr; Fig. 4). Dark grey dolomitic quartzite and minor light

[1] In naming metamorphic rocks, the constituent minerals are listed in decreasing order of relative abundance.

green quartz-muscovite-chlorite-dolomite (± biotite) schist are also intercalated with the grit and beige dolomitic schist that dominates Unit 1gr. The ubiquitous presence of dolomite distinguishes this unit from other map units in the area. The contact with the surrounding massive quartzite is not exposed and, therefore, the exact nature of the relationship between Unit 1gr and the quartzite of Unit 1 is unknown. Unit 1gr probably extends eastward along the north shore of Pelly River (Campbell, 1967, p. 41).

UNIT 2 (LOWER METAVOLCANIC UNIT)

Unit 1 is transitionally overlain by a lithologic assemblage which is dominated by rocks of volcanic parentage (Unit 2). North of Macmillan River, the base of Unit 2 corresponds to a sequence of intercalated tan weathering, "waxy," quartz-muscovite-feldspar (± chlorite) schist (felsic metavolcanic rock), carbonaceous phyllite and minor gritty quartzite (Unit 2fv). A light grey to white, finely recrystallized marble occurs near the top of Unit 2fv. The marble is intercalated with dark grey to black phyllite and dark green chloritic phyllite.

Figure 2. *Well-bedded quartzite (Unit 1), Pelmac Ridge. View is to the west, with dominant foliation (Sd) dipping shallowly to the north. Hammer at left-centre for scale.*

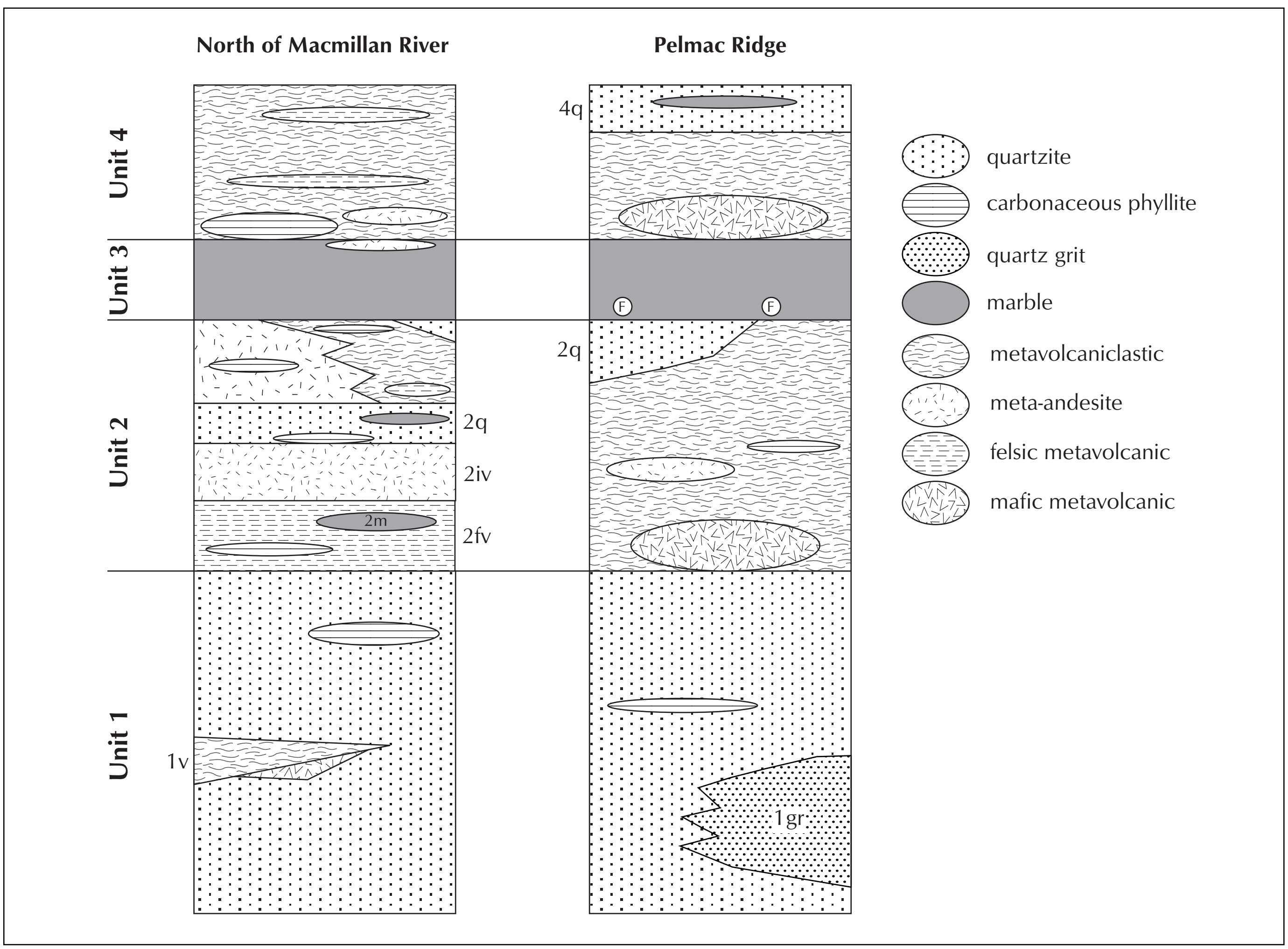

Figure 3. *Schematic representation of stratigraphic relations in the Little Kalzas Lake area. (Symbols shown in Fig. 4.)*

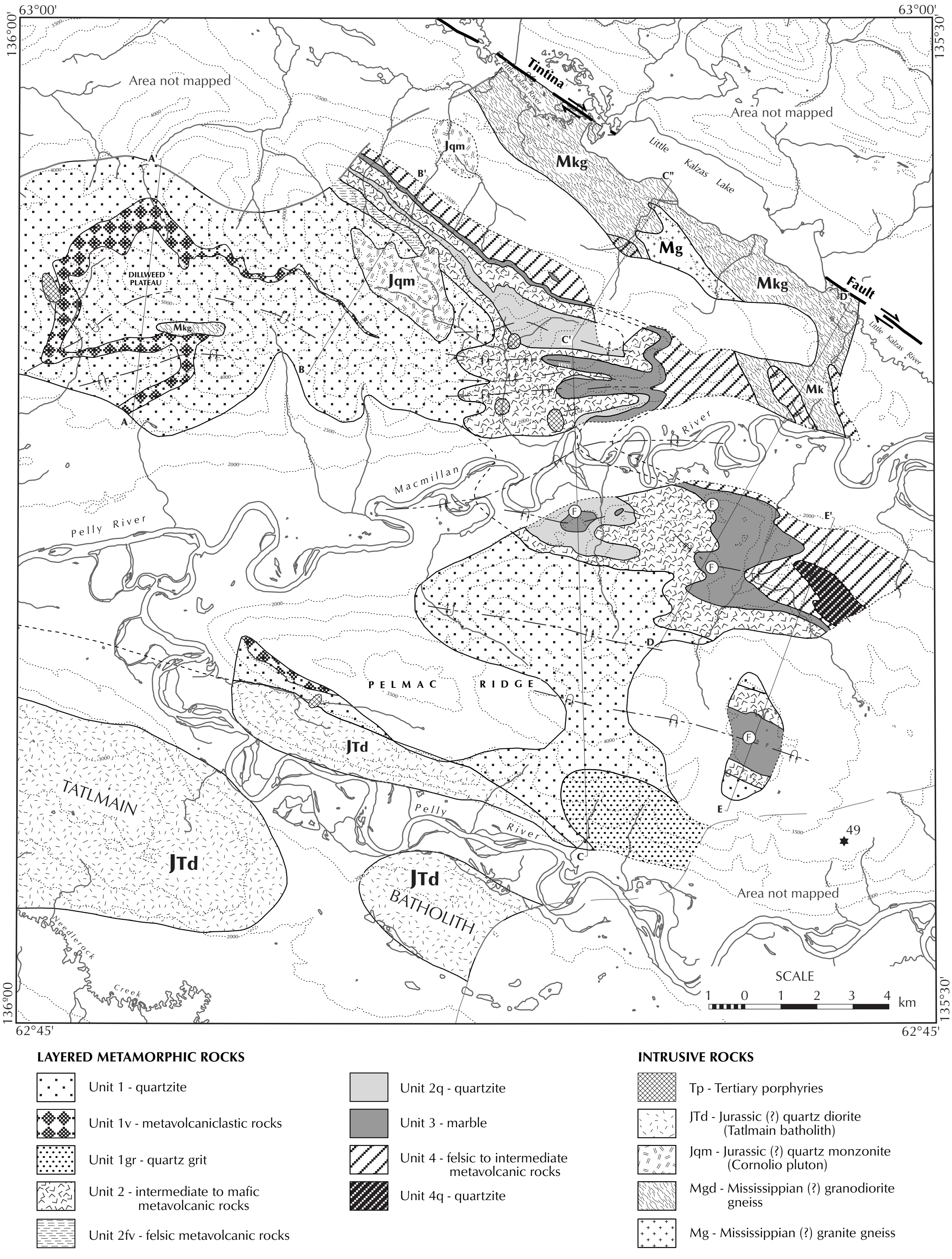

Figure 4. *Geological map of the Little Kalzas Lake area (105L/13). F = occurrences of crinoidal marble in Unit 3. Number 49 indicates location of mineral occurrence 105L 049 (Hugh, Gal; Yukon Minfile). Straight lines between letters are location of cross sections shown in Figure 5.*

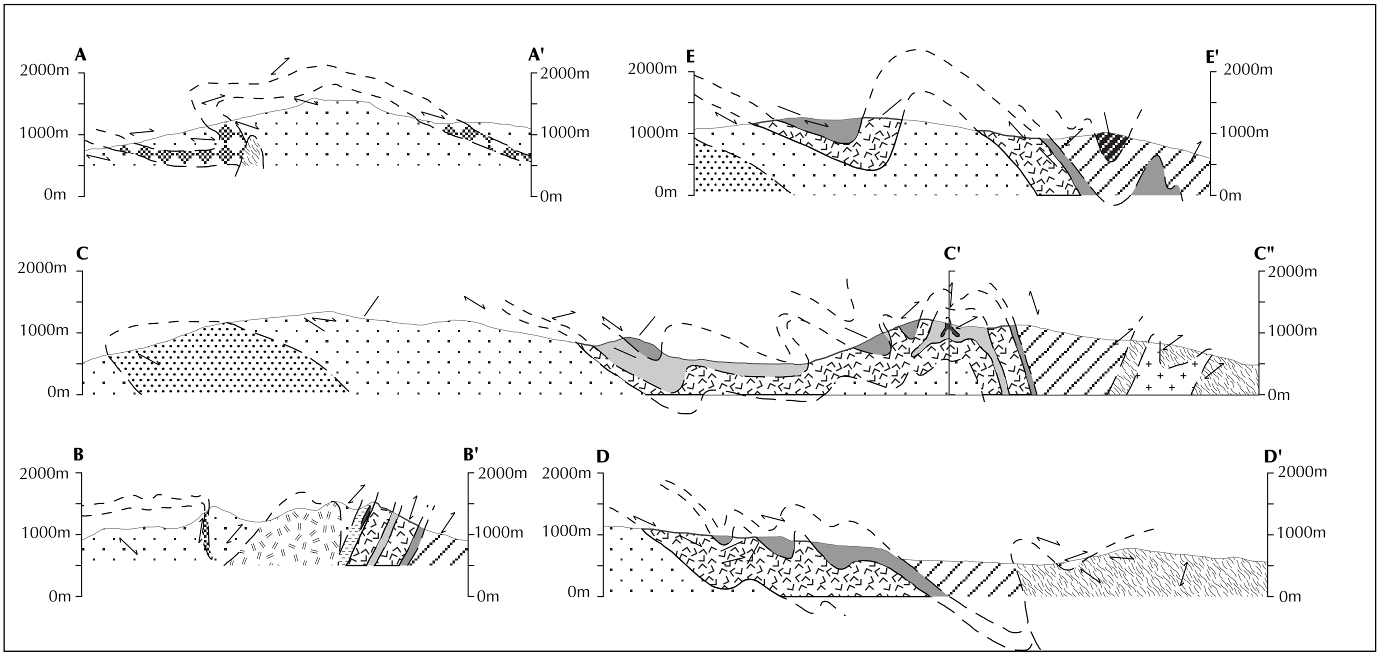

Figure 5. *Vertical cross sections for the Little Kalzas Lake area. Line of sections and legend are located in Figure 4.*

The most prominent rock type in Unit 2, north of Macmillan River, is massive to foliated, dark green to black, fine-grained plagioclase-epidote-hornblende-biotite-calcite meta-andesite (Unit 2iv, Fig. 3). The meta-andesite is commonly plagioclase-phyric (Fig. 6) and typically contains disseminated pyrite. Quartzo-feldspathic and/or epidote-rich segregations locally occur within the meta-andesite. A white to dark grey cherty quartzite and minor dark grey phyllite unit (Unit 2q) occurs in the middle of the meta-andesite. The quartzite is typically less than 100 m thick along alpine ridges; it apparently thickens to the east, where it is poorly exposed in a heavily forested valley. There, a white marble occurs within the quartzite in the core of an upright antiform (Figs. 4 and 5). Above the quartzite, the meta-andesite is intercalated with dark grey phyllite and passes eastward into a tan weathering, light grey, calcareous muscovite-chlorite phyllite and minor felsic quartz-muscovite-feldspar schist (Fig. 3).

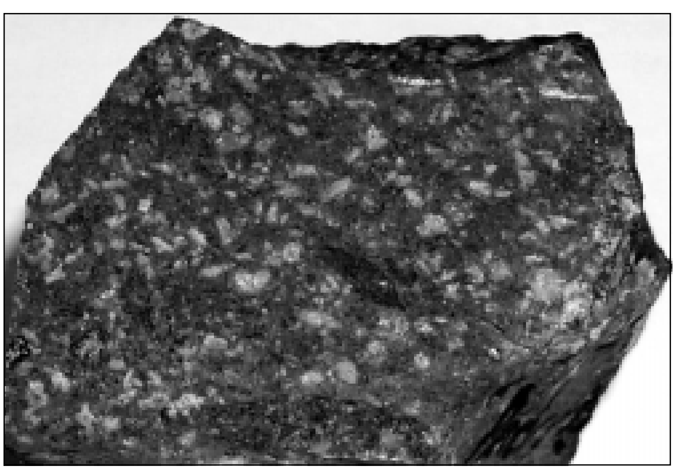

Figure 6. *Plagioclase-phyric meta-andesite (Unit 2). Hand sample is approximately 5 cm across.*

Near Macmillan River, and on Pelmac Ridge to the south, Unit 2 is dominated by light to medium green, muscovite-quartz-chlorite phyllite and micaceous quartzite (metavolcaniclastic rocks) with minor intermediate to mafic metavolcanic rocks and felsic quartz-muscovite-feldspar schist. On Pelmac Ridge, the metavolcanic rocks of Unit 2 include a massive, feldspar-sericite-biotite-titanite schist which contains lapilli-sized clasts of chlorite-calcite-plagioclase up to 3 cm long. The top of Unit 2 locally is marked by a foliated white to medium grey quartzite intercalated with 1-5 mm thick beds of dark grey carbonaceous phyllite. Elsewhere, metavolcanic rocks that underlie marble of Unit 3 are typically calcareous.

UNIT 3 (MARBLE)

A conspicuous laterally persistent marble divides metavolcanic rocks of Unit 2 from those of Unit 4 (Fig. 3). The marble is typically light grey to white and locally weathers to a light buff colour. Near Macmillan River, the marble occurs in large masses in the hinge zone of folds. It commonly contains well-preserved crinoids (meta-packstone; Fig. 7) and is locally cherty. North of Macmillan River, the marble is much thinner and extensively recrystallized. It is locally phyllitic and closely associated with meta-andesite and carbonaceous phyllite.

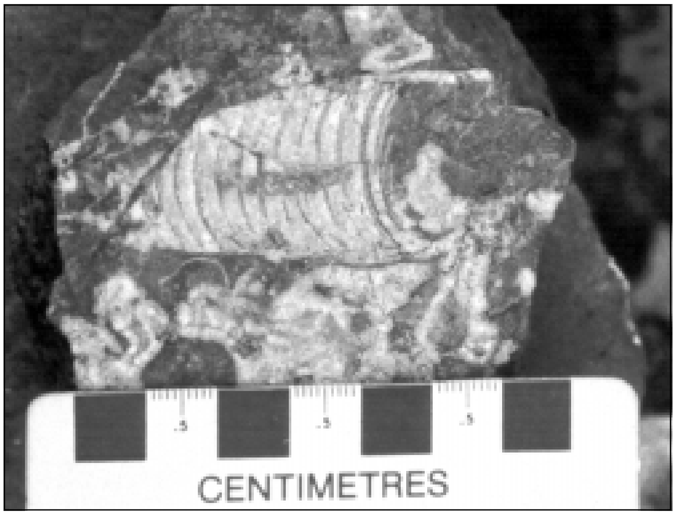

Figure 7. *Well preserved crinoid from marble (Unit 3), south of Macmillan River.*

UNIT 4 (UPPER METAVOLCANIC UNIT)

Unit 4 is generally poorly exposed and comprises a mixture of metasedimentary and metavolcanic rocks. North of Macmillan River, Unit 4 includes carbonaceous phyllite and quartzite, meta-andesite and felsic metavolcanic rocks. The felsic schist is most prominent along the slopes on the north side of Macmillan River. It is a light grey to light green, "waxy" muscovite-quartz-feldspar schist which locally contains millimetre-scale quartz and feldspar augen. On Pelmac Ridge, Unit 4 is dominated by light green quartz-muscovite-chlorite phyllite and light green quartzite and grit (metavolcaniclastic rocks) intercalated with minor intermediate to mafic metavolcanic rocks. There, the lower part of Unit 4 is a massive chlorite-epidote-actinolite-plagioclase schist (greenstone). The highest stratigraphic unit consists of white, green and pink dolomitic quartzite intercalated with 0.5-5 cm-thick brown weathering dolomitic beds (Unit 4q; Fig. 4).

INTRUSIVE ROCKS

The layered metamorphic rocks are intruded by at least three suites of intrusive rocks. The oldest suite is penetratively deformed with the country rocks; the two younger suites postdate deformation.

In the northeastern part of the map area, along the southwestern side of Tintina Trench, the multi-phase Little Kalzas orthogneiss complex, of uncertain age (possibly Mississippian), comprises an older granodioritic gneiss (Mgd) which is intruded by a granitic gneiss (Mg). Both phases contain abundant xenoliths of country rock. The granodioritic gneiss (Mgd) is typically a medium to dark green, fine- to medium-grained, chlorite-epidote-plagioclase-quartz-biotite ± hornblende ± K-feldspar ± muscovite ± tourmaline gneiss. Near Macmillan River, the granodioritic gneiss commonly contains K-feldspar megacrysts (Fig. 8). It occurs as a sill complex within the metasedimentary and metavolcanic rocks of Unit 4. The granodioritic gneiss is massive to strongly foliated, the foliation being most penetrative at the margin of individual sills. The granodioritic gneiss is intruded by a strongly foliated, coarse-grained, quartz-plagioclase-chlorite-epidote-biotite granitic to tonalitic gneiss (Mg). Disseminated pyrite occurs in all phases of the Little Kalzas orthogneiss complex and within xenoliths of country rock.

A small body of meta-igneous rocks of uncertain age (Mississippian?) intrudes metasedimentary and metavolcanic rocks of Unit 1 along the south flank of Dillweed Plateau (Dillweed orthogneiss, Mgd; Fig. 4). The Dillweed orthogneiss is a medium grey to medium green, medium to coarse-grained, plagioclase-chlorite-muscovite-quartz ± biotite ± K-feldspar porphyritic quartz diorite to granodiorite gneiss. The orthogneiss is strongly foliated and locally intercalated with light green chlorite-muscovite-quartz phyllite of Unit 1v, suggesting that the orthogneiss was perhaps a subvolcanic intrusion.

The post-kinematic Cornolio pluton (informal name; 5.5 km SW of Little Kalzas Lake) intrudes the layered metamorphic rocks in the north-central part of the map area (Jqm; Fig. 4). It is an unfoliated to weakly foliated medium-grained hornblende ± biotite quartz monzonite. A few isolated outcrops of medium- to coarse-grained, hornblende quartz monzonite also occur along

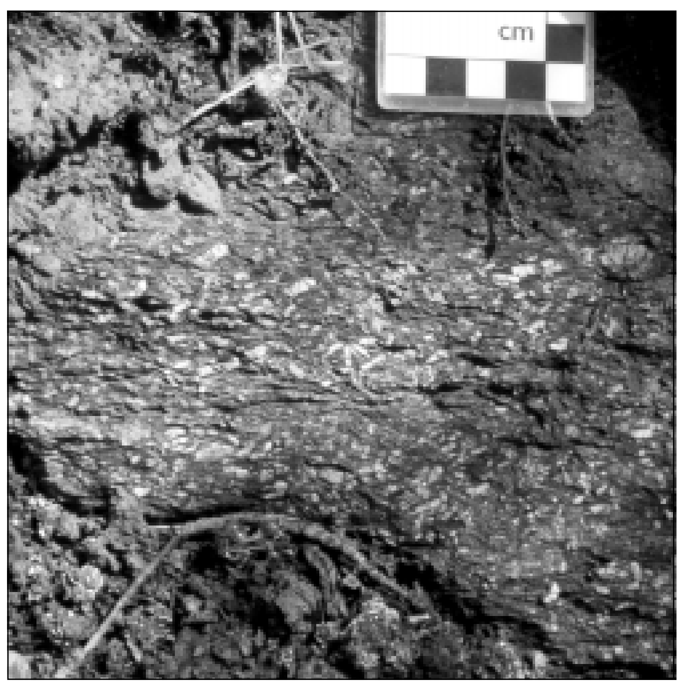

Figure 8. *Foliated, K-feldspar megacrystic orthogneiss, Little Kalzas orthogneiss complex, near Macmillan River.*

Figure 9. *South southwest-verging fold in metavolcaniclastic rocks of Unit 2, Pelmac Ridge. View to the northwest.*

a creek about 3 km north of the main body of the Cornolio pluton (Fig. 4). In that locality, hornblende defines a weak foliation which is probably of magmatic origin. Country rocks in the metamorphic aureole of the main body of the Cornolio pluton contain cordierite (± sillimanite) indicating that the pluton was emplaced at high level in the crust. The age of the Cornolio pluton is uncertain.

The southwest corner of the map area is underlain by the Tatlmain batholith (Tempelman-Kluit, 1984; JTd, Fig. 4). It is composed of medium- to coarse-grained, equigranular hornblende ± biotite quartz diorite. A Jurassic age is assigned to the Tatlmain batholith based on similarity in composition with the Tatchun batholith in the southern part of Glenlyon map area (Campbell, 1967) which yielded Middle Jurassic K-Ar dates from hornblende and biotite (Tempelman-Kluit, 1984).

The youngest intrusive rocks in Little Kalzas Lake area are small plugs of quartz-feldspar porphyry (Tp; Fig. 4). Three types of porphyries are recognized based on their colour and composition and abundance of phenocrysts. The most common type of quartz-feldspar porphyry is pink to reddish-brown in colour, and contains up to 30% plagioclase (5 mm) and smoky quartz (< 2 mm) phenocrysts. This pink porphyry occurs in four small bodies, 100-400 m in diameter, in the north-central part of the map area (Fig. 4), one of which yielded a U-Pb zircon date of 55 ± 1.7 Ma (Mortensen and Jackson, unpublished). West of Dillweed Plateau, and at one locality north of Cornolio pluton, a grey rhyolite porphyry contains < 10% micro-phenocrysts (< 1 mm) of smoky quartz and plagioclase. Finally, a white quartz-feldspar ± biotite porphyry containing up to 60-70% phenocrysts intrudes the contact between the Tatlmain batholith and micaceous quartzite and carbonaceous phyllite (Unit 1) at the western end of Pelmac Ridge (Fig. 4).

STRUCTURE

The dominant tectonic fabric in the area is a pervasive transposition foliation and mineral lineation. Although primary layering has generally been transposed parallel to foliation, primary textures are preserved in local low-strain domains (e.g., Figs. 6 and 7). The intense deformation recorded by the dominant structures has not disrupted the stratigraphic sequence at the scale of the map area (Fig. 4), in contrast to regional models previously suggested for Yukon-Tanana Terrane (e.g., Tempelman-Kluit, 1979).

The transposition foliation is axial-planar to tight, gently west northwest- or south southeast-plunging, south southwest-verging folds (Figs. 5 and 9). The foliation and axial surfaces progressively change toward the northeast from NNE-dipping to upright to south southwest-dipping (Fig. 6). Locally, the dominant folds deform a schistosity suggesting that an older deformation event affected the area. However, the regional significance of this older deformation event has yet to be established.

A mineral lineation, defined by orientation of elongate minerals (primarily micas and quartz) on planes of the dominant foliation, is generally parallel to fold axes and bedding/foliation intersections. It is commonly a penetrative quartz rodding in massive quartzite on Dillweed Plateau where the mineral lineation constitutes the dominant fabric element.

The dominant structures are deformed by a younger crenulation cleavage which strikes to the northwest and dips moderately to the northeast. This crenulation cleavage is axial-planar to broad open folds (Fig. 10) which plunge gently to the southeast (together with the crenulation lineation). These open folds have only limited regional significance; they are responsible for the broad doming of the dominant foliation near Dillweed Plateau.

Figure 10. *Broad open fold of the dominant foliation in micaceous quartzite of Unit 1, east of Dillweed Plateau.*

The dominant south southwest vergence of the major structures in Little Kalzas Lake area differs from recent structural interpretations proposed for the Teslin zone, approximately 150 km to the southeast, where major structures have a predominant northeast vergence (e.g., Gallagher et al., 1998; de Keijzer et al., in press). However, the style of deformation recorded in Little Kalzas Lake area is consistent with that of the Big Salmon Complex farther south, near the 60th parallel, where major folds are southwest- and west southwest-verging (Mihalynuk et al., 1998). At this stage, our limited knowledge of the regional geology of Yukon-Tanana Terrane precludes a proper resolution of the apparent variability in the style and orientation of deformational features reported from various locations along strike.

MINERAL OCCURRENCES

Only a single Yukon Minfile occurrence is present in the Little Kalzas Lake area southwest of Tintina Fault (Yukon Minfile, 105L 049; Hugh, Gal; Fig. 4). This occurrence was delineated on the basis of an airborne magnetic anomaly and subsequently examined for base metal and gold mineralization (Sheldrake, 1986). Inconclusive results from geochemical and VLF-EM surveys did not justify further work on this occurrence. Although there is no exposure in the area, the magnetic anomaly is most likely hosted in quartzite of Unit 1 (Fig. 4).

No new mineralization was encountered during mapping of Little Kalzas Lake area. However, the occurrence of altered felsic schist (light green in colour) in Unit 4 along the slopes north of Macmillan River (UTM Zone 8, 467222E, 6976148N), and the local abundance of pyrite in the same area, require further investigation.

DISCUSSION

Although with important differences, the stratigraphy and structural style of the rocks of Little Kalzas Lake area are similar to those of Yukon-Tanana Terrane across Tintina Trench. Precise correlation between the rocks of Little Kalzas Lake area and those elsewhere in Yukon-Tanana Terrane cannot be attempted until the necessary geochemical, biostratigraphic, and geochronological studies have been done. However, some general statements can be made on the basis of field relationships.

- The occurrence of voluminous clean quartzite is perhaps one of the most distinguishing characteristics of the stratigraphic sequence mapped in Little Kalzas Lake area (Figs. 3 and 4). Clean quartzite is a relatively uncommon lithology in Yukon-Tanana Terrane; it is a minor constituent of the Nasina assemblage west of Dawson, approximately 280 km to the northwest (Mortensen, 1988a, 1988b; 1992). The presence of clean quartzite in Little Kalzas Lake area therefore suggests a possible correlation with the Nasina assemblage of west-central Yukon.
- The crinoidal marble of Unit 3 is the most promising horizon for stratigraphic linkage with other parts of Yukon-Tanana Terrane. Latest Mississippian to Early Permian fossiliferous marble occurs sporadically throughout Yukon-Tanana Terrane (cf. Mortensen, 1992; his Fig. 5). Latest Mississippian marble occurs below an important unit of mafic to intermediate metavolcanic rocks in the Big Salmon complex of northern British Columbia and the southern Yukon (Mihalynuk et al., 1998). Upper Paleozoic marble is also present in the Finlayson Lake district (Tempelman-Kluit, 1977; Mortensen, 1992). Several samples of Unit 3 marble are being analyzed for microfossils. If the Unit 3 marble yields a Late Mississippian-Pennsylvanian age, then the upper metavolcanic sequence (Units 2 and 4) of Little Kalzas Lake area is most likely coeval with the upper part of Yukon-Tanana stratigraphy (which hosts the Wolverine deposit) as defined by Murphy and Piercey (this volume) in the Finlayson Lake District.

IMPLICATIONS FOR MINERAL EXPLORATION

The recognition of bimodal felsic and mafic metavolcanic rocks in Little Kalzas Lake area has obvious implications for the mineral potential of the area. It affirms some correlation with the rocks of the Finlayson Lake massive sulphide belt in Yukon-Tanana Terrane northeast of Tintina Trench, thereby substantially increasing the prospectivity of Yukon-Tanana Terrane southwest of Tintina Trench for these types of deposits. Further indications of massive sulphide potential include altered felsic schist and locally abundant pyrite. Finally, although no massive sulphide mineralization was encountered in the course of mapping of Little Kalzas Lake area, a new occurrence of magnetite-bearing semi-massive sulphide was found in outcrops of altered felsic schist along the Campbell Highway about 95 km along strike to the south (see Colpron, this volume).

SUMMARY

Regional mapping of Little Kalzas Lake area during the summer of 1998 identified a previously unknown stratigraphic succession which includes a lower quartzite sequence (Unit 1) and an upper metavolcanic sequence (Units 2-4). Occurrences of metavolcanic rocks in this area, as well as the discovery of sulphide-bearing horizon in similar rocks farther south, suggests a high potential for the discovery of VMS deposits in Yukon-Tanana Terrane of the Glenlyon map area.

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